A GUIDE TO THE AIRCRAFT MAINTENANCE ENGINEER'S LICENCE EXAMINATIONS

(Revised to July, 1949)

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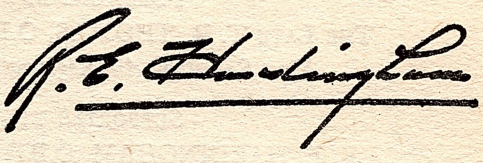
The Foreword shown opposite was written by the late T. R. Thomas for the first edition of this Handbook. What he said then remains true to-day and I have asked that it should remain unaltered.



Secretary,
Air Registration Board.

Foreword . . .

I have pleasure in agreeing to the request that I should write a short Foreword to this book.

As the examining authority for the licensing of aircraft engineers, the Board appreciates the difficulties with which the candidate is faced. He must not only have the necessary knowledge to enable him to satisfy the examiners that he is a fit and proper person to hold a licence, but he must also, more important still, *demonstrate* to his examiners that he has the requisite knowledge. To do this, is not always easy for a man who is not accustomed to expressing either by the written or spoken word his knowledge of a subject, although this may be quite adequate for the purpose.

It seems to me that this booklet is most valuable in helping a candidate over both these difficulties. The information given in it has been submitted to and checked by the Board's officers. I am sure it will encourage every aircraft engineer to improve his standard of knowledge and help those who are not already licensed to obtain this valuable qualification.

T. G. Thomas

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AIRCRAFT MAINTENANCE ENGINEER'S LICENCE EXAMINATIONS

I

General

When World War I ended and the aeroplane was first used for commercial purposes, it was found necessary, in the interests of public safety, to exercise some authoritative control. The Air Navigation Act of 1920 was therefore drawn up and passed, by which the regulations and requirements governing the design, construction and maintenance of aircraft registered in the United Kingdom became the responsibility of the Secretary of State for Air. The Air Ministry was responsible for Service aircraft, and it was decided to set up, within the Ministry, a Department of Civil Aviation. This department was responsible for prescribing the necessary regulations which were published as Statutory Orders, and these, although much amended, remain the basis of the present day regulations. One of these regulations requires that every Civil Aircraft should possess a Certificate of Airworthiness and that if it is being operated for hire or reward, the aircraft, including its engines, must be certified periodically as safe for flight; aircraft used for flying instruction also come within this category. Further, any repairs or overhauls must be certified as having been carried out in accordance with the requirements.

The responsibility for ensuring the satisfactory construction of Civil aircraft was vested in a branch of the Aeronautical Inspection Directorate, which continued its technical duties on behalf of the Secretary of State for Air until these duties were delegated to the Air Registration Board.

The distribution of public service aircraft operating throughout the country meant that if the certifications were to be made without undue delay, it would be necessary either to have sufficient inspectors of the Directorate available for this purpose, or for the Secretary of State for Air to delegate this duty to other competent persons. As engineers would necessarily be engaged on the maintenance of aircraft,

the logical solution was to make provisions to enable certain of them to inspect their own work, or that of others, and to certify compliance with all the Requirements and Regulations.

It was decided, therefore, to license engineers for these inspection and certification duties. Subject to the qualifications prescribed for the licence being met, and on the recommendation of the A.I.D., engineers became licence holders and thus inspectors acting on behalf of the Secretary of State for Air. The licence holders were known as " Ground Engineers ". A number, to be quoted when signing a certification, was allotted to each licence. The licence authorised the holder either to make certifications in respect of safety for flight, or for overhauls and repairs, according to the terms of the licence.

In 1937, the Secretary of State delegated certain technical duties to the Air Registration Board, and in 1938, the Board assumed the responsibility for examining applicants for Engineers' Licences. The Board made its recommendations to the Air Ministry (Department of Civil Aviation) in respect of these licences until the Ministry of Civil Aviation Act was passed in 1945. Under this Act an independent Ministry was set up and the responsibility for Civil aviation matters, previously held by the Secretary of State for Air, was transferred to the Minister of Civil Aviation. Recommendations were then made to the new Ministry and holders of licences have since been acting on behalf of the Minister of Civil Aviation.

Up to 1945, the procedure of oral examination originally adopted by the A.I.D. before recommending the grant or extension of a licence, had not changed for nearly twenty-six years. In view of the general desire to raise the standard and of the obvious advantages of a written examination, it was decided at this time to adopt a revised procedure. At the same time, it was considered that the term " Ground Engineer ", as applied to an inspector of aircraft, was misleading, for the title gave no indication of the work on which the licence holder might be engaged. The A.R.B., therefore, when making recommendations to the Minister of Civil Aviation concerning the qualifications of licence holders also recommended that holders of licences should in future be known as " Licensed Aircraft Engineers ". This recommendation was accepted, and on the 1st March, 1946, the Aircraft Maintenance Engineer's Licence was introduced. The word " Maintenance " was originally inserted to distinguish the licence from that held by an Aircraft Operational Engineer, now known as a Flight Engineer.

The A.R.B. first published its minimum requirements for the grant and extension of licences in Sub-Sections A.28 and A.29 of British Civil Airworthiness Requirements. These Requirements have since been re-issued as Section " L " of the Requirements, which has recently been subjected to major amendment to take account of international recommendations. The United Kingdom concurs with

the standards proposed by the International Civil Aviation Organisation (I.C.A.O.) for Aircraft Maintenance Engineer's Licences, and this concurrence is reflected in the A.R.B.'s Requirements. This third edition of this booklet takes account of the second and, at the time of publication, latest issue of Section "L".

The A.R.B. is anxious that there should be close liaison between its Surveyors and aircraft engineers. In order to maintain a high standard in the profession of aircraft engineering, the A.R.B. has instructed its Surveyors to report at intervals on the capabilities of engineers stationed in their particular area.

It is not necessary for every engineer employed on work in connection with Civil aviation to be licensed, but it is essential that every organisation concerned with the operation of aircraft should have a quota of licence holders in order that the certifications required by the Regulations may be made.

The licence is not, and should not be regarded as a Certificate of Competence to do certain work. It is an authority to certify that any work done on the aircraft or engine has been executed in accordance with the Regulations. A licence holder, of course, may act in a dual capacity—that of workman and inspector. This sometimes makes his position difficult and it should be clearly understood that when the work is finished and he inspects and certifies it, he is at that point acting under the authority granted to him by the Minister of Civil Aviation.

A licence holder's position while acting on behalf of the Minister is one of responsibility, and the lives of passengers in aircraft may depend on the quality of his inspection and the integrity of his certification. If at any time he fails properly to use the powers that have been given to him, and in accordance with the Regulations, his licence may be cancelled or suspended.

The purpose of this booklet is to summarise and explain the more important regulations and requirements applicable to licensed aircraft engineers. It is framed so as to give intending applicants for licences all the guidance they require, up to the time of application, without actual recourse to the Regulations.

II

Categories of Licences

CATEGORIES "A" AND "B"

The ratings of these categories are:—

Aeroplanes. Licences may be recommended for the types of aeroplanes as detailed in paragraph 5 of the current issue of Notice to Licensed Aircraft Engineers and to Owners of Civil Aircraft No. 10.

Helicopters. A licence in Category "A" will not be recommended except in conjunction with a licence in Category "C" to cover the particular type of engine installed.

Gliders.

CATEGORIES "C" AND "D"—ENGINES

The ratings of these categories are as detailed in paragraph 6 of the current issue of Notice to Licensed Aircraft Engineers and to Owners of Civil Aircraft No. 10.

NOTE: A licence in Category "C" to cover the certification of an engine in a helicopter will not be recommended except in conjunction with a licence in Category "A" to cover the particular type of helicopter in which the engine is installed.

CATEGORY "X"

The ratings of this category are:—

The installation and compensation of compasses in aircraft.
The overhaul, repair, or modification of engine ignition apparatus.

The overhaul, repair, modification and installation of variable-pitch propellers.

The overhaul, repair, modification and installation of aircraft and engine instruments, including or excluding electrically-operated instruments.

The overhaul, repair, modification and installation of electrical equipment.

The overhaul, repair, modification and installation of automatic pilots.

III

Duties of Engineers Licensed in Various Categories

CATEGORY "A"

The duties which may be performed by the holder of a licence in Category "A" are:—

1. *Certification, in A.R.B. Form 268, as to the fitness for flight of an aircraft for which a certificate of airworthiness is about to be issued.*

The first of a particular type of aircraft is called a "Prototype" aircraft, and after it has been fully approved and granted a Certificate of Airworthiness, serves as a pattern for all subsequent aircraft, known as "Series" aircraft. These, in turn, will be granted certificates of Airworthiness if they conform to the "Prototype", except for approved modifications.

For a "Prototype" aircraft about to receive a C. of A., the certificate in Form 268 is signed by a representative of the Air Registration Board. In the case of "Series" aircraft, the certificate in the form on p. 13 is signed by a representative of the constructors concerned, holding an "A" licence covering the type of aircraft concerned, after a satisfactory final inspection has been completed.

CERTIFICATE OF FINAL INSPECTION FOR FITNESS FOR FLIGHT

I/WE hereby certify that the aircraft defined herein has been inspected in accordance with the requirements of the Air Navigation Regulations, and is this day safe in every way for flight providing it is properly loaded.

Signed ..... Date.....

Aircraft Maintenance Engineer: Licence No.....

Signed ..... Date.....

Aircraft Maintenance Engineer: Licence No.....

(The first signature required is that of an engineer licensed in Category "A", and the second must be that of an engineer licensed Category "C").

2. *Certification, in the manner prescribed in the Air Navigation Regulations, as to the safety for flight of public transport aircraft.*

The duty which an aircraft maintenance engineer licensed in Category "A" is most often called upon to perform, is the issue of the Certificate of Safety for flight.

The certificate is valid for the length of time prescribed in the approved Maintenance Schedule for the particular aircraft concerned. It ceases to be valid when the prescribed time expires or if the aircraft sustains a serious defect. The expression "serious defect" means such a defect as would not, in accordance with the ordinary aeronautical practice, be remedied by the pilot or crew. When a Certificate of Safety ceases to be in force as a result of a serious defect, a Licensed Aircraft Engineer will be in order in issuing a new Certificate provided :

(1) he is satisfied that the defect, and any consequential defects have been remedied.

(2) details of the defect or defects and the action taken to remedy the defect or defects, have been recorded and duly certified.

(3) he is satisfied that on the basis of the information provided by the operator that up to the time of the issue of such certificate, all maintenance and inspection required to be carried out in accordance with the approved maintenance schedules for the aircraft, have been so carried out.

Every aircraft which is used for public transport must be inspected before flight in accordance with Maintenance Schedules which have been approved by the A.R.B. Aircraft which are used for flying instructional purposes are also considered to be public transport aircraft.

The owner or hirer of an aircraft is required to furnish such information as may be necessary to enable an aircraft engineer, who is to sign the certificate, to be satisfied that, up to the date of issue of such certificate, all maintenance and inspection required in accordance with the approved Maintenance Schedules for the aircraft have been carried out.

After the necessary inspection has been made, a certificate in the following form must be completed: —

* *CERTIFICATE OF SAFETY*

Aircraft Type .....

Nationality and Registration Marks .....

I hereby certify that I am satisfied that the above aircraft (including its prescribed instruments and equipment, but excluding the engines and engine installations and all instruments relating thereto) is safe in every way for flight, provided that the conditions of loading specified in the certificate of airworthiness are complied with, and I hereby certify that all maintenance and inspection in accordance with the approved maintenance schedules have been carried out and that adjustments and rectifications found necessary have been made and inspected to my satisfaction.

Signed .....

Aircraft Maintenance Engineer: Licence No. .....

Time of issue .....

Dated at..... this ..... day of ..... 19.....

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* This certificate includes the attachment of the radio apparatus to the aircraft structure and the conditions of the earth system of the aircraft, including the bonding and screening to ensure suppression of high frequency electrical interference. It does not include the radio apparatus.

The magnetic compasses may be adjusted and compensated by the holder of a licence in the appropriate rating of Category " X " (or by the holders of the appropriate aircrew licences), who will certify to that effect on the deviation cards. In such cases, on the next certificate of safety issued after the adjustment or compensation, the certificate may be altered by the insertion after the word " equipment ", the words " other than magnetic compasses ". The alteration must be initialled by the aircraft engineer who issues the certificate.

NOTE: In connection with this certificate, and all other certificates of a similar nature, it is emphasised that engineers should not attempt to learn the wording by heart. The prescribed form only is legal, and the effect of a word added, subtracted, transposed, or altered, is to destroy the validity of the certificate. What is important is that engineers should know the gist of the different forms of certificates, the circumstances under which they should be employed, and where they are to be found. It should further be noted that this book is not a recognised source of reference in this connection, owing to the possibility of there having been an amendment since this book was printed. **Reference should be made in case of doubt to the current Air Navigation Order or Regulations, as the case may be.**

3. *Certification, in the log book, of work done under approved Maintenance Schedules.*

These Schedules, which must be approved by the A.R.B., are drawn up by the operator or owner of the aircraft, with the assistance of information* provided by the aircraft and engine makers.

4. *Certification, in the log book, of repairs approved as minor repairs.*

Minor repairs can be defined as repairs which do not affect the strength or safety of the structure, and have been approved as minor by the A.R.B.

5. *Certification, in the log book, of modifications approved as minor modifications.*

An "A" licensed engineer may only carry out modifications approved as " minor " by the A.R.B.

6. *Certification, in the log book, of the replacement of approved components and parts.*

It is necessary that there should be some guarantee that material used in making repairs, and spares or components which may be fitted, conform in quality and workmanship to the requirements laid down by the designer and approved by the A.R.B.

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* The Society of Licensed Aircraft Engineers has printed a Specimen Maintenance Schedule, copies of which may be obtained at the cost of 2/6 each.

This is done by means of Approved Certificates (numbered serially and issued consecutively), despatched with each batch of material, components or spares, supplied by an organisation approved to do so by the A.R.B.

The Approved Certificate bears on it the name of the firm or organisation, the A.R.B.'s Approval Number, a brief description of the material, spares or components, and a statement certifying that "the whole of the material and/or parts detailed hereon has been tested, inspected, and conforms to the full requirements of the drawings and/or specifications relative thereto, in accordance with the conditions of the Air Navigation Regulations and the general requirements of the Air Registration Board". This is signed by the Chief Inspector or other responsible representative of the firm authorised to do so by the A.R.B.

Items 3, 4, 5 and 6 may also *be certified by a "B" licensed engineer in the log book.*

A certificate in the following form must be made out and should follow particulars of the work done, repairs or modifications carried out or parts replaced. If the log book is not available, the certificate must be made out on a separate sheet of paper for inclusion in the log book at a later date.

CERTIFICATE OF COMPLIANCE

Aircraft Type.....

Nationality and Registration Marks.....

I hereby certify that in carrying out the

{ work done under the approved maintenance schedule
repairs
modification
replacement

specified above, all the conditions and requirements of the Air Navigation Regulations for the time being in force which are applicable thereto have been complied with.

Signed .....

Authority .....

Date .....

When the particulars of the work are so lengthy that it would be inconvenient to enter them in the space provided in the log book, the particulars may be entered on a separate record which must be

numbered for identification purposes, certified in the same manner as required for the same entry if made direct into the log book, and retained in safe custody in order that it may be produced for inspection. The entry in the log book then includes the reference number of this record and where it may be inspected, together with a brief description only of the work to which the record relates.

The Aircraft Engineer licensed in Category "A" is required to certify all parts of the aircraft except the engine(s) and/or power plant(s) and their installation, as follows:—

All parts of the airframe structure, for assembly, condition and, where applicable, functioning.

All airframe controls, for connection, security of attachment, condition, assembly and correct functioning, including:—

All flying controls

All trimming devices

All controls connected to the airframe equipment.

All flying instruments and instruments required for any particular installations*, for connection, security of attachment, functioning, condition and arranging for correction of reported faults.

Direct reading compasses for connection, security of attachment and condition.

Remote reading compass systems for connection, security of attachment, condition and functioning checks.

Items of equipment, including:—

Automatic pilots for connection, security of attachment and functioning checks as specified in the respective makers' instructions.

Radio equipment for connection and security of attachment to the airframe structure.

Hand fire extinguishers, safety belts, safety harness, seats or bunks, towing and tethering gear attachments, for connection, security of attachment, condition, assembly and functioning.

Tables, oxygen masks, life belts, dinghies, axes, all marine mooring gear, for connection, security of attachment, condition and security of stowage.

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* Any instrument or item of equipment that requires adjustment or calibration during or after installation must be certified in conjunction with an aircraft engineer licensed in Category "X" in the appropriate rating of the Category.

All parts of installations required for operating any of the above items, for connection, security of attachment, condition and functioning, including: —

Cockpit and cabin heating and air conditioning systems.
De-icing systems except those listed under Category " C '.
Oxygen, hydraulic and pneumatic systems.
Pressurization systems.
Fire prevention, detection and extinguishing systems.
Venturi and vacuum systems.
Pitot and static systems.
All parts of wheel brake operating gear.
All parts of the flap operating gear.
All parts of the retractable landing and float operating gear.
All wiring and piping leading to any items or systems classified under Category "A".

Electrical system* for connection, security of attachment, condition, continuity†, insulation†, functioning and arranging for correction of reported faults.

All bonding connections to the airframe for connection, security of attachment, condition and continuity.

Emergency exits, for connection, security of attachment, condition and functioning.

NOTE.—When periodical opening tests of an emergency exit are necessary to ensure that it is in working order, the appropriate interval between tests is determined by the A.R.B.

CATEGORY " C "

The duties which may be performed by the holder of a licence in Category " C " are: —

1. *Certification, in A.R.B. Form 268, as to the fitness for flight of the engines in an aircraft for which a certificate of airworthiness is about to be issued.*

The first of a particular type of aircraft is called a " Prototype " aircraft, and after it has been fully approved and granted a Certificate of Airworthiness, serves as a pattern for all subsequent aircraft, known

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* Any instrument or item of equipment that requires adjustment or calibration during or after installation must be certified in conjunction with an aircraft engineer licensed in Category " X " in the appropriate rating of the Category.

† Applicable to Aeroplanes specified in paragraphs 5.1, 5.2, and 5.3 of the current issue of Notice to Licensed Aircraft Engineers and to Owners of Civil Aircraft No. 10. For Aeroplanes in paragraphs 5.4, and 5.5, of the Notice, certification can be made only in conjunction with an aircraft engineer licensed in the appropriate rating of Category " X ".

as " Series " aircraft. These in turn will be granted Certificates of Airworthiness if they conform to the " Prototype ", except for approved modifications.

For a " Prototype " aircraft about to receive a C. of A., the certificate in Form 268 is signed by a representative of the Air Registration Board. In the case of " Series " Aircraft, the certificate in the form below must be signed by a representative of the contructors concerned, holding a " C " licence covering the type of engine concerned, after satisfactory final inspection has been completed.

CERTIFICATE OF FINAL INSPECTION FOR FITNESS FOR FLIGHT

I/WE hereby certify that the aircraft defined herein has been inspected in accordance with the requirements of the Air Navigation Regulations, and is this day safe in every way for flight providing it is properly loaded.

Signed ..... Date .....

Aircraft Maintenance Engineer: Licence No. .....

Signed ..... Date .....

Aircraft Maintenance Engineer: Licence No. .....

(The first signature required is that of an engineer licensed in Category "A", and the second must be that of an engineer licensed in Category " C".)

2. *Certification, in the manner prescribed in the Air Navigation Regulations, as to the safety for flight of engines in public transport aircraft.*

The duty which an aircraft maintenance engineer licensed in Category " C " is most often called upon to perform, is the issue of Certificate of Safety for Flight.

The certificate is valid for the length of time prescribed in the approved Maintenance Schedule for the particular aircraft concerned. It ceases to be valid when the prescribed time expires or if the aircraft sustains a serious defect. The expression " serious defect " means such a defect as would not, in accordance with ordinary aeronautical practice, be remedied by the pilot or crew. After rectification of the defect and the appropriate log book entry has been made by an approved person, the validity of the certificate is automatically restored.

The engines of every aircraft which is used for public transport must be inspected before flight in accordance with Maintenance Schedules which have been approved by the A.R.B. Aircraft which are used for flying instructional purposes are also considered to be public transport aircraft.

The owner or hirer of an aircraft is required to furnish such information as may be necessary to enable an aircraft engineer, who is to sign the certificate, to be satisfied that, up to the date of the issue of such certificate, all maintenance and inspection required in accordance with the approved Maintenance Schedules for the particular installation have been carried out.

CERTIFICATE OF SAFETY

I hereby certify that I am satisfied that the engine(s) and engine installations (including all prescribed instruments relating thereto) of the above* aircraft are safe in every way for flight, and I hereby certify that all maintenance and inspection in accordance with the approved maintenance schedules have been carried out and that adjustments and rectifications found necessary have been made and inspected to my satisfaction.

Signed .....

Aircraft Maintenance Engineer: Licence No.....

Time of issue .....

Dated at ..... this..... day of .....19.....

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*The aircraft type, nationality, and registration marks are entered above the certificate relating to the aircraft, and signed by the engineer licensed in Category "A". The certificate quoted above, which has to be signed by the "C" licensed engineer, normally follows.

NOTE: In connection with this certificate, and all other certificates of a similar nature, it is emphasised that engineers should not attempt to learn the wording by heart. The prescribed form only is legal, and the effect of a word added, subtracted, transposed, or altered, is to destroy the validity of the certificate. What is important is that engineers should know the gist of the different forms of certificates, the circumstances under which they should be employed, and where they are to be found. It should further be noted that this book is not a recognised source of reference in this connection, owing to the possibility of there having been an amendment since this book was printed. **Reference should be made in case of doubt to the current Air Navigation Order or Regulation as the case may be.**

3. *Certification, in the log book, of work done under approved Maintenance Schedules.*

These Schedules, which must be approved by the A.R.B., are drawn up by the operator or owner of the aircraft, with the assistance of information* provided by the aircraft, propeller and engine makers.

4. *Certification, in the log book, of the rectification of defects, the embodiment of approved modifications, and the replacement of approved parts, provided that this work has not involved dismantling of the engine other than to obtain access to the pistons, cylinders and valve operating gear.*

Only modifications which have been approved as "minor" by the A.R.B. may be incorporated by a "C" licensed engineer, and these only within the limits of dismantling mentioned. Two other instances of permitted dismantling in usual practice may be noted: while a "C" licensed engineer may not change a reduction gear, he may certify removal of a reduction gear and replacement of the same one, if this is necessary when checking for propeller shaft shock loading; for ease of transport, propellers are often despatched and received more or less dismantled and with blades removed, after having been assembled, inspected and passed as satisfactory by the manufacturers or repair works. An engineer whose licence covers V.P. propellers may certify re-assembly, in addition to correct attachment to the engine, and correct functioning.

It is necessary that there should be some guarantee that material used in making repairs, and spares or components which may be fitted, conform in quality and workmanship with the requirements laid down by the designer and approved by the A.R.B.

This is done by means of Approved Certificates (numbered serially and issued consecutively), despatched with each batch of material, components or spares, supplied by an organisation approved to do so by the A.R.B.

The Approved Certificate bears on it the name of the firm or organisation, the A.R.B.'s Approval number, a brief description of the material, spares or components, and a statement certifying that "the whole of the material and/or parts detailed hereon has been tested, inspected, and conforms to the full requirements of the drawings and/or specifications relative thereto, in accordance with the conditions of the Air Navigation Regulations and the general requirements of the Air Registration Board". This is signed by the Chief Inspector or other responsible representative of the firm authorised to do so by the Board.

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* The Society of Licensed Aircraft Engineers has printed a Specimen Maintenance Schedule, copies of which may be obtained at the cost of 2/6 each.

Items 3 and 4 may also be certified by a " D " licensed engineer, except in respect of the assembly of variable-pitch propellers.

A certificate in the following form must be made out and should follow particulars of the work done, repairs or modifications carried out or parts replaced. If the log book is not available, the certificate must be made out on a separate sheet of paper for inclusion in the log book at a later date.

CERTIFICATE OF COMPLIANCE

Engine Type .....

Number .....

I hereby certify that in carrying out the

{ work done under the approved maintenance schedule
repairs
modification
replacement

specified above, all the conditions and requirements of the Air Navigation Regulations for the time being in force which are applicable thereto have been complied with.

Signed .....

Authority .....

Date .....

When the particulars of the work are so lengthy that it would be inconvenient to enter them in the space provided in the log book, the particulars may be entered on a separate record, which must be numbered for identification purposes, certified in the same manner as required for the same entry if made direct into the log book, and retained in safe custody in order that it may be produced for inspection.

The entry in the log book should then include the reference number of this record and where it may be inspected, together with a brief description only of the work to which the record relates.

The Aircraft Engineer licensed in Category "C" is required to certify the engine(s) and/or power plant(s) including all parts and systems essential to their installations, as follows * :—

All parts of the power plant(s), including:—

Engine, for condition, installation and power output.
Engine bearers, for condition and security of attachment.
Auxiliary gear boxes, engine driven cabin blowers, engine driven generators, engine starting systems, fuel, vacuum, pressure and de-icing pumps, for security of attachment, condition and arranging for correction of reported faults.

All controls connected with the engine(s) or power plant(s) and their ancillary systems, for security of attachment, condition, assembly and correct functioning.

All engine and/or power plant instruments †, for security of attachment, functioning, condition and arranging for correction of reported faults.

Propellers, for installation, condition, smooth running and, in the case of V.P. propellers, assembly and functioning.

Constant speed units and feathering pumps, for installation, condition and functioning.

All parts of installations required for operating any of the above items, for installation, condition and functioning, including:—

All fuel systems (including tanks).
All oil systems (including tanks).
All propeller, injector and/or carburettor de-icing systems.
Heaters (exhaust or coolant operated).
All engine cowlings.
Fire prevention, detection and extinguishing systems.
All wiring and piping except as defined in Category "A".

Electrical system, including:—

All parts pertaining to the engine and/or power plant and controls, for condition, continuity, insulation, functioning and arranging for correction of reported faults.
Bonding and screening of parts classified under Category "C", for condition and continuity.
Ignition system, for condition, functioning, continuity and insulation.

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* *NOTE*: When removal of an instrument or repair of an installation system involves the detachment of wiring or pipe lines from the airframe, or the opening up of the airframe, the work of removal and replacement should be done in collaboration with an aircraft engineer licensed in Category "A".

† Any instrument or item of equipment that requires adjustment or calibration during or after installation must be certified in conjunction with an aircraft engineer licensed in Category "X" in the appropriate rating of the Category.

CATEGORIES "B" AND "D"

The duties which may be performed by the holder of a licence in Categories "B" and "D" are:—

CATEGORY "B"

1. *Certification, in the log book, of the overhaul of aircraft, including engine installation; except that the overhaul, repair or modification of instruments, automatic-pilots, variable pitch propellers, or electrical equipment shall have been previously certified by a firm approved for the purpose, or by an aircraft maintenance engineer licensed in Category "X".*

CATEGORY "D"

1. *Certification, in the log book, of the overhaul of engines; except that the overhaul, repair, or modification of engine ignition apparatus shall have been previously certified by a firm approved for the purpose, or by an aircraft maintenance engineer licensed in Category "X".*

2. *Certification, in the log book, of approved repairs.*

3. *Certification, in the log book, of approved modifications.*

4. *Certification, of the construction and replacement of parts, and of the materials used therefor.*

NOTE: A licence in Category "B" or "D" may be granted excluding the certification of the construction of components and parts and materials used therefor.

While modifications and repairs, classified as "minor" may be certified by holders of Categories "A", "C", "B" or "D", all major overhauls of aircraft or components, and all major modifications and repairs must be certified by an appropriately licensed engineer in Category "B" or "D", or by a firm which has been approved for the purpose by the A.R.B.

Modern practice, owing to the complexity of aircraft, tends to make use of certification by an Approved Firm rather than by an individual licensed engineer, but the extent of the experience and knowledge necessary before an individual can obtain a licence are based on the assumption that he is competent to certify an overhaul, repair, modification or replacement which is carried out by an unapproved organisation. It is therefore necessary that he should have a knowledge of the material used, the correct manufacturing processes involved, and the correct functioning of the whole, when the defective part has been replaced or repaired.

In addition to the knowledge outlined in the previous paragraph, an engineer licensed in Category "B" or "D" must certify, each

overhaul, repair, replacement or modification, in the manner prescribed in Air Navigation Regulations. It should be noted that the word "aircraft", in Air Navigation Regulations, includes the engine(s), components, accessories, instruments, equipment, and apparatus, and their installations.

The certification prescribed in Air Navigation Regulations, in legal form, requires that when an aircraft, which is registered in the United Kingdom and in respect of which a certificate of airworthiness has been issued or validated by the Minister of Civil Aviation, is subjected to overhaul, repair, replacement, or modification, the following conditions must be complied with.

These conditions, summarised with certain provisos, are that:—

(i) The work must, in all essential respects, be in accordance with either:—
  (a) the approved type design in conformity with which the aircraft was constructed, or
  (b) a repair scheme approved by the Air Registration Board.

(ii) In the case of repairs, overhauls, replacements or modifications, all material used must be an approved equivalent to that authorised for the type design in conformity with which the aircraft was constructed.

(iii) In all cases, all work must be inspected in accordance with the conditions required for the inspection of aircraft that are applicable to the case.

(iv) In all cases a certificate must be appended to particulars of the overhaul, repair, modification or replacement to which it relates and is in the following form:—

I hereby certify that in carrying out the

{ overhaul / repair / modification / replacement }

specified above, all the conditions and requirements of the Air Navigation Regulations for the time being in force which are applicable thereto have been complied with.

Signed .....

Authority .....

Date .....

Such certificates must be entered in the appropriate log book and signed by an engineer qualified under the terms and conditions of his licence to certify the overhaul, repair, modification, or replace-

ment to which the certificate relates or by the authorised representative of a firm or company approved for the purpose of granting such certificates.

When the particulars of the work are so lengthy that it would be inconvenient to enter them in the space provided in the log book, the particulars may be entered on a separate record which must be numbered for identification purposes, certified in the same manner as required for the same entry if made direct into the log book, and retained in safe custody in order that it may be produced for inspection.

CATEGORY "X"

The duties which may be performed by the holder of a licence in Category "X", according to the ratings in which he is licensed, are:—

1. *Certification, in the log book, of the installation and compensation of compasses.*

2. *Certification of the overhaul, repair or modification of engine ignition apparatus and of replacements thereto.*

3. *Certification, in the log book, of the overhaul, repair or modification of variable pitch propellers, and of replacements thereto.*

4. *Certification of the overhaul, repair, or modification of aircraft and engine instruments, and of replacements thereto.*

5. *Certification of the overhaul, repair, or modification of electrical equipment and of replacements thereto.*

6. *Certification of the overhaul, repair, modification and installation of automatic pilots, and of replacements thereto.*

Engineers licensed in Categories "A", "C", "B" and "D" are, according to the Category in which they are licensed, expected to have a general knowledge of all the instruments and equipment and their functions, employed in civil aircraft. This is sufficient to enable them to exercise their certifying powers in respect of the whole assembly, but the growing complexity both of instruments and of auxiliary plant and equipment has made it necessary, in the interests of safety in flight, to create a "Specialist" class of

licence to cover the overhaul and repair of specific items. This enables the "A", "C", "B" or "D" Category engineer to obtain a supporting certificate from a specially qualified source before he signs his own clearance whether of fitness for flight or for overhaul of airframe or engine.

To this category the general description of "X" is applied, the particular items in respect of which it is issued taking the form of individual endorsements. An "X" licence may be held by a genuine specialist with a single endorsement only, but there is nothing to prohibit a number of such endorsements being held by one man nor, of course, the possession of an "X" licence by an engineer licensed in "A", "C", "B" or "D" Category.

The items for which "X" licence endorsements are at present recommended by A.R.B. include those for which a Certificate by an "X" Category engineer is compulsory under existing Air Navigation Regulations.

For example :

An engineer licensed in Category "A" may not sign the Certificate of Safety for Flight for an aircraft, which carries a compass as one of the instruments prescribed by Statutory Order, unless he has previous evidence of the certification of the adjustment of the compass by an engineer licensed for this purpose in Category "X", or by the holder of the appropriate air-crew licences.

Similarly, an engineer licensed in Category "C" may not give the necessary clearance for an engine fitted with a new or repaired variable pitch propeller, unless he is able to produce the authority of an Approved Firm or engineer licensed in Category "X" for variable pitch propellers which should be recorded in the propeller log book.

Again, the "A" or "B" licensed engineer must have the support of an "X" licence man or an Approved Firm for the overhaul or repair of electrical equipment and instruments, and the "D" licensed engineer must have an Approved Certificate from an Approved Firm or the certificate of an "X" licensed engineer for the overhaul of electrical equipment associated with the engine, including engine ignition apparatus.

From this it will be seen that for the installation and adjustment of compasses, the overhaul, repair or modification of electrical services or instruments, engine ignition apparatus, variable pitch propellers or automatic pilots, a certificate given by an engineer in Category "X" or an approved certificate issued by a firm appropriately approved, is necessary under existing regulations.

After ensuring that the work conforms in all essential respects with the conditions as specified in the previous sections (Categories "B" and "D"), a certificate in the following form must be completed:—

I hereby certify that in carrying out the

{ overhaul
repair
modification
replacement }

specified above, all the conditions and requirements of the Air Navigation Regulations for the time being in force which are applicable thereto have been complied with.

Signed .....

Authority .....

Date .....

The purpose of the "X" licence is—

to provide the assurance necessary to the "A", "C", "B" and "D" licensed engineer that all items of equipment which have been overhauled have been inspected in accordance with the regulations.

EXTENSION OF LICENCES

1. A preliminary application form obtainable from the Secretary, Air Registration Board, Brettenham House, Strand, London, W.C.2, must be completed in respect of each extension, to show details of the applicant's experience, and returned to the Board.

2. If the experience detailed in the preliminary application is satisfactory to the A.R.B., the applicant will be requested to complete and return a final application on M.C.A. Form 2D, together with the fee of £1 0s. 0d.

3. An applicant must have had the experience, and must pass all or any of the examination subjects appropriate to the extension required.

RE-EXAMINATION

Applicants who fail to pass the examination, in respect of the grant or extension of a licence, will not be accepted for further examination for the same duties of certification as previously applied for, until additional knowledge has been gained of such duties. In these cases it may be necessary for the A.R.B. to advise the applicant what further practical experience it considers necessary.

RENEWAL OF LICENCES

1. An application on M.C.A. Form 2D, obtainable from the Secretary, Air Registration Board, Brettenham House, Strand, London, W.C.2, must be completed and returned to the Board, together with a fee of £1 0s. 0d. Should re-examination be necessary, the holder of the licence will be notified by the A.R.B. and an additional sum will be chargeable, making £2 0s. 0d. in all.

2. Licences are normally valid for a period of twelve months and may be renewed without re-examination of the applicant. In particular cases, however, the applicant may be required to satisfy all or any of the conditions and requirements for the grant of a licence. A licence may not be renewed if, within the preceding twenty-four calendar months, the holder has not served as a licensed aircraft maintenance engineer, within the limitations of the licence, for at least six months. The holder may be required at any time to demonstrate to competent authorities that he is able to meet the standards prescribed for the grant of a licence.

3. During the period of validity of a licence, the holder must inform the A.R.B. of any change of address or place of employment.

IV

Procedure for the Grant, Extension and Renewal of Aircraft Maintenance Engineer's Licences

Aircraft maintenance engineer licenses are granted, extended and renewed by the Ministry of Civil Aviation on the recommendation of the A.R.B. Such recommendations are made subject to applicants complying with the conditions and requirements set out in the following paragraphs.

GRANT OF LICENCES

1. An applicant must not be less than 21 years of age.

2. An applicant must be able to read, write and converse in the English language.

3. A preliminary application form obtainable from the Secretary, Air Registration Board, Brettenham House, Strand, London, W.C.2, must be completed in respect of each application, to show details of the applicant's experience, and returned to the Board.

4. If the experience detailed in the preliminary application form is satisfactory to the A.R.B., the applicant will be requested to complete and return a final application on M.C.A. Form 2B, together with the fee of £2 0s. 0d.

5. An applicant must have had the experience, and must pass the examinations, appropriate to the category of licence required, as detailed in Chapter VI, Syllabus of Examinations.

V

The Form of Examination

The examination for Ground Engineers' Licences were, in the past, entirely oral. A large proportion of applicants did not overcome their feelings of nervous uneasiness throughout the interview, and were hardly in a frame of mind to do themselves full justice.

The examinations for Maintenance Engineers' Licences, which have taken the place of Ground Engineers' Licences, are in two parts. The first, and main, part is a written examination occupying two and a half to three and a half hours, according to category and rating, and this covers the major part of the syllabus. If the applicant reaches a satisfactory standard in this written examination, he qualifies for a short oral examination, the main purpose of which is to establish personal contact with the applicant, and assess his knowledge of the Regulations and practical inspection.

All the questions on the written papers must be attempted.

To assist examinees in apportioning their time to the best advantage, a form of examination paper is used in which a space is left after each question for the insertion of the appropriate answer. This space has been carefully calculated to provide sufficient space for the answer, written in a normal hand with reasonable economy of words. Should more space be required, the answer can be continued on the back of the paper. It should be noted, however, that the space is sufficient for an adequate answer. *It is understood that some of the best papers have been completed well within the spaces provided.*

The examination papers are printed on foolscap paper. The average time taken to complete one side of a sheet of foolscap—broken up by three or more questions—is half an hour, and this forms a rough guide to progress against the clock throughout the examination.

A facsimile of a typical question for Categories "A" and "C", showing this arrangement, is included in this book. Specimen question papers for Categories "B" and "D" are also included. For practice, these questions should be copied out full scale on to sheets of foolscap, with spaces to allow for the answers, as indicated. Then the questions should be answered in the spaces provided, taking care to eliminate unwanted words or phrases. For example, if the question is "How should the flying controls be inspected for . . . .", it is obviously a waste of words, space and time to commence the answer by repeating the question, saying, "I should inspect the flying controls for . . . . .". Instead, start right in on the real meat of the answer, never mind the trimmings. Try to imagine that instruction is being given to an apprentice and then answer all his possible queries as to exactly *HOW* the inspection checks should be done.

Provided that the correct answer is given, and all the points raised in the question are covered, no marks are deducted for bad writing, lack of neatness, or mistakes in spelling, and no apprehension need be felt on that score.

SPECIMEN

AIR REGISTRATION BOARD

Table No:
Seat No:

AIRCRAFT MAINTENANCE ENGINEER'S LICENCE EXAMINATION CATEGORY 'A'

All Questions Must be Attempted and Answered for (Type of Aircraft)*

SIGNATURE OF APPLICANT: DATE: TIME HRS.

1. A main plane is 4.6 ft. wide and its total length is $15\frac{3}{4}$ ft. It has a semi-circular wing tip and square root end. How many square feet of fabric are required to cover it ?

2. Define "Angle of Incidence". How is it measured and in what form are the measurements expressed ?

3. Define "Stagger". How is it measured and in what form are the measurements expressed ?

4. If the control column in the cockpit of an aircraft on the ground is moved to the right and forward, what is the effect on the control surfaces ?

---

* This is a specimen question paper covering aeroplanes in paragraph 5.1 and 5.2 of Notice to Licensed Aircraft Engineers and to Owners of Civil Aircraft No. 10. Examination papers for heavier landplanes or seaplanes are of a similar form with the addition of questions relating to retractable landing gear, hulls and floats, etc.

5. What inspection is required on a flying control system after replacement of a stranded cable.

6. How is the wear taken up in an expanding shoe type of cable operated wheel brake ? When the brake operation is co-ordinated with the rudder movement, what precautions must be taken in the adjustment of the brake cables ?

7. What defects may account for an aircraft flying left wing low ? What checks are necessary to find the causes ? How should the defects be remedied ?

8. Indicate the movement of the elevator trimmer tab and explain the operation when the cockpit control is moved to the "nose-down" position.

9. What checks are necessary on an electric storage battery and what maintenance is required ? State the type of battery to which your answer refers.

10. An aircraft has been operating during a long spell of wet weather. To what would your inspection be particularly directed ?

11. Describe briefly the undercarriage shock absorbing device. What are its common defects and what periodical maintenance is required ?

12. How should a tear in a fabric cover be repaired ? Illustrate with a rough sketch and give particulars of the fabric work and doping involved.

13. How does an altimeter function and how is it checked for calibration ?

14. Write a brief inspection report describing the possible damage and repairs necessary to a fabric covered main plane after the tip had struck the ground during landing. Illustrate position of damage by sketch.

SPECIMEN

AIR REGISTRATION BOARD

Table No:
Seat No:

AIRCRAFT MAINTENANCE ENGINEER'S LICENCE EXAMINATION CATEGORY 'C'

All Questions Must be Attempted and Answered for (Type of Engine)*

SIGNATURE of APPLICANT: DATE: TIME HRS.

1. What is the cubic capacity of a cylinder of 4" bore and 4·25' stroke ? Show full working.

2.a. How is the compression ratio of an engine determined ?

2.b. How many revolutions of the crankshaft are necessary to complete the cycle of operations in all the cylinders of the engine ?

3. What defects in the engine would influence a decision to carry out a "top overhaul"?

4. During a rectification, what check should the "C" Licensed Engineer make on the connecting rod assembly ? If it is found defective, can he certify the replacement of a connecting rod ?

---

* This is a specimen question paper covering a small unsupercharged engine fitted with fixed pitch propeller. The questions for the examination paper covering air-cooled or liquid-cooled engines are of similar form with the addition of questions relating to the inspection and maintenance of superchargers, V.P. propellers and controls, etc.

5. What checks should be made on, and what defects are likely to be encountered in, the following parts during rectification :- (i) valve springs, (ii) detachable cylinder heads (bare)?

6. What are the worn clearances or tolerances usually permitted in the following cases:- (i) piston and cylinder, (ii) ovality of cylinder, (iii) valves and guides.

7. Describe the checks made during run-up of an engine which has just been installed. State type.

8. The needle valve of a carburettor has been replaced ; what checks are necessary and how are they carried out ?

9. Detail the procedure when fitting a magneto to an engine, and the necessary inspection checks.

10. What checks should be made on a replacement airscrew before and after fitting to the engine ?

11. Describe the principles of operation of any type of oil pressure gauge. What error in reading is permitted ?

12. What precautions must be taken in the installation of a mechanically driven revolution indicator ?

13. What are the most likely defects which could cause an engine to overheat ?

14. What checks are necessary during and after re-assembly of a fuel system ?

15. Sketch the internal and external lubrication system of the engine. State type of aircraft.

The following are two further examples of Examination papers: —

SPECIMEN *

AIR REGISTRATION BOARD

Aircraft Maintenance Engineers' Licences
Written Examination

CATEGORY "B"
Aircraft types
(Overhaul and repair only)

For practice these questions should be set out on foolscap paper and answers written within the space indicated.

ALL QUESTIONS MUST BE ATTEMPTED.

1. A plank of spruce 21 ft. long by $10\frac{1}{2}''$ x $7\frac{1}{2}''$ is taken from the timber store and a piece 6" long is weighed in order to ascertain the density of the plank. The 6" piece weighs 6 lb. 10 oz. and the moisture content is 20%. What will the density be in lb. per cubic foot when the timber is dried out to a moisture content of 15%? (Space for answer 2 inches).
2. (*a*) Mention two types of glues or cements which are used in wooden aircraft construction and repair. State how they are prepared, applied and tested. (Space for answer 2 inches).
2. (*b*) How is a fabric cover attached to an aeroplane wing? Does the size of the aircraft have any bearing on the method used? (Space for answer $1\frac{3}{4}$ inches).
2. (*c*) How is the humidity of the dope room ascertained and what Board of Trade requirements must be observed in respect of the operating personnel? (Space for answer $1\frac{1}{4}$ inches).
3. (*a*) What treatment is applied to fittings after welding? Does the same treatment apply to a welded tubular structure or can it be dispensed with? If so, how? (Space for answer $1\frac{1}{4}$ inches).
3. (*b*) What inspection is necessary to prove the satisfactory condition of a welded joint? (Space for answer $1\frac{3}{4}$ inches).
4. (*a*) What precautions must be observed when using duralumin rivets, and how can they be distinguished from aluminium ones? (Space for answer $2\frac{1}{4}$ inches).

---

* *This is a specimen question paper covering aircraft listed in paragraphs 5.1 and 5.2 of Notice to Licensed Aircraft Engineers and to Owners of Civil Aircraft No. 10. The questions for the examination paper for large landplanes or seaplanes are of a similar form with the addition of questions relating to the overhaul and repair of retractable landing gear, hulls and floats.*

4. (*b*) What precautions must be taken when storing duralumin and aluminium sheet? (Space for answer $\frac{3}{4}$ inch).

5. (*a*) Detail the process inspection on an aircraft fuel tank during repair. (Space for answer 2 inches).

5. (*b*) What is the difference between the various grades of solder used, and how can they be identified and which particular grades are in general use on aircraft? (Space for answer 2 inches).

6. (*a*) What final inspection, before covering, is necessary on a skeleton wire braced wooden main plane, that has been fitted with a new front spar? (Space for answer 2 inches).

6. (*b*) Enumerate the final dimensional checks that are made on an assembled aircraft. State tolerances. (Space for answer $1\frac{1}{2}$ inches).

NOTE: This specimen question paper is not necessarily complete, and applicants will be expected to answer a greater variety of questions than shown in the foregoing examples.

SPECIMEN *

AIR REGISTRATION BOARD

Aircraft Maintenance Engineers' Licences
Written Examination

CATEGORY "D"
(Unsupercharged engines)
(Overhaul and repairs only)

For practice these questions should be set out on foolscap paper and answers written within the space indicated.

ALL QUESTIONS MUST BE ATTEMPTED.

1. What checks are made on the crankshaft of an in-line engine during overhaul? What are the average permissible allowances for wear and distortion? (Space for answer $2\frac{1}{4}$ inches).

2. What defects are encountered in gear-wheels? How can these be treated and what limits the amount of the rectification that can be carried out? (Space for answer $2\frac{1}{2}$ inches).

---

* *This is a specimen question paper covering small unsupercharged engines as listed in paragraph* 6. 1 *of Notice to Licensed Aircraft Engineers and to Owners of Civil Aircraft No.* 10. *The questions for the examination paper covering large air-cooled or liquid-cooled engines are of a similar form with the addition of questions relating to the inspection of the construction, overhaul and repair of superchargers, controls for V.P. propellers, etc.*

3. What inspection is necessary in the fitting of a six-throw crankshaft to the crankcase of an in-line engine during overhaul? Numbers 2 and 4 bearings replaced by new ones. (Space for answer $2\frac{3}{4}$ inches).
4. Give a brief description of the apparatus used for the purpose of testing engines after complete overhaul, stating the differences between that employed for (i) an air-cooled radial engine and (ii) an in-line engine. (Space for answer $3\frac{1}{4}$ inches).
5. How is the B.H.P. ascertained at any given stage in the case of an engine being tested (i) with a calibrated test fan (ii) with a dynamometer ? How are the results obtained cocrrected to standard conditions in every respect? (Space for answer $3\frac{1}{4}$ inches).
6. How are carburettor jets calibrated? How are they marked and what does the calibration denote? (Space for answer $2\frac{1}{2}$ inches).
7. Describe briefly the method of timing the valve operation of an engine and the inspection necessary to ascertain its correctness on all the cylinders of an overhauled engine. (Space for answer 3 inches).
8. Prepare a sketch from which a drawing can be made of the main thrust bearing of either a radial or an in-line engine. (Space for answer 3 inches).

NOTE: This specimen question paper is not necessarily complete, and applicants will be expected to answer a greater variety of questions than shown in the foregoing examples.

SPECIMEN

AIR REGISTRATION BOARD

Aircraft Maintenance Engineers' Licences
Written Examination — CATEGORY "X"
(Compasses Direct Reading)

1. Briefly describe the duties and responsibilities of an Aircraft Engineer licensed in Category "X" Compasses.
2. What is understood from the term "Aperiodic" ? Explain how a compass is constructed to come under this heading.
3. Define the difference between "magnetic deviation" and "magnetic variation".
4. (*a*) What is card error ? (*b*) What tolerance is allowed ? (*c*) What errors can this cause ?
5. (*a*) Detail the necessary checks on a Compass Base.
   (*b*) Why should it be necessary to check a Compass Base ?
   (*c*) How often would you check a Compass Base ?

6. If a Compass Base were not available, describe briefly any alternative method which could be employed in swinging a compass in an A/c.

7. Define briefly the following : Magnetic Moment, Dip, Parallax, Gauss, Unit Pole.

8. Explain why the magnets in a compass are usually made short in comparison with the length of the compass needle, which is of non-magnetic material. What would result if the needle were made of magnetic substance as in the case of a Marching Compass ?

9. What proof should accompany a new or overhauled aircraft compass to show that it has been tested and was known to function correctly ? On what authority and by whom is this done ?

10. What is a Magnet ? What is Polarity and how is it indicated when it has been determined ?

11. How is the strength of a magnet defined ? Of what material are compass magnets generally made to ensure as far as possible that no strength is lost due to shock and vibration when installed in an Aircraft ?

12. Sketch and describe a type of Corrector Box with which you are familiar. Detail the method of " Neutralization ".

13. Detail as many reasons as you can which create the necessity for swinging a compass.

14. Detail how you would swing an A/c Compass afloat. Explain the method you would employ and detail the results which you obtained.

15. Describe briefly any type of Bearing Plate which you have used.

16. Plot a graph and give the deviations on the following readings :

    22° ; 112° ; 249° ; 291°.

17. Make a " Steer By " Card and fill in the Reverse side.

FOR	STEER

18. What is Dip ? How is this corrected for in an A/c Compass ?

SPECIMEN

AIR REGISTRATION BOARD

Aircraft Maintenance Engineers' Licences
Written Examination

CATEGORY "X"
(Extension of Compass Licence to include Distant Reading Gyro Magnetic Compass)

1. State advantages of a Distant Reading Gyro Magnetic Compass.
2. Give a step by step description of the operation of the Master Unit.
3. What important inspections should be carried out prior to installation of a D.R.C. in an aircraft ?
4. How are the following components installed in an aircraft :— (a) Master Unit? (b) Variation Setting Control? (c) Repeater? List the necessary checks and inspections after installation.
5. Explain how you would carry out a swing. State where you would take your readings and where and what corrections you would make.
   Detail the precautions to be taken when swinging.
6. How is "Hunt" of the Inner Frame prevented from showing on the Repeaters ? What are the likely causes of "Hunt" showing on Repeaters ?
7. State any reasons which may cause desynchronization of Repeaters.
8. How are Repeaters made to synchronize with the Master Unit ? Detail how adjustments (when necessary) are made.
9. Detail a Daily Inspection on a Distant Reading Compass installed in an aircraft.
10. Explain the construction and operation of the Transmitting methods employed (do not include the V.S.C.).

SPECIMEN

AIR REGISTRATION BOARD

Aircraft Maintenance Engineers' Licences
Written Examination

CATEGORY "X"
(Ignition Equipment)

1. Describe all components of given type magneto.
2. Describe functions of various components.
3. Describe inspections and tests on all components during overhaul. Give figures.
4. How is the cam ring timed electrically ?
5. What tests and checks are made on a magneto during assembly ?
6. Describe endurance test after overhaul, include spark gap.

7. Sketch and describe a standard spark gap. Give the gap settings and voltages.
8. What defects may be encountered on a contact breaker during inspection ?
9. Give details of the periodical checks and inspections to be carried out on an ignition system.
10. What precautions should be taken when dismantling a magneto for overhaul ?
11. Describe the procedure for fitting a new distributor cover to a magneto.
12. Ditto all other components.
13. What tests would you give a magneto after overhaul ? Give speeds and figures.
14. Describe the tests you would carry out on an ignition harness before returning it to service. Give figures.
15. Describe how you would remagnetize a magnet.
16. What tests would you carry out on a condenser—primary winding—secondary winding—driving overhaul ?
17. What effect will an over magnetized magnet have on the running of a magneto ?
18. What is the "E" gap ?
19. What checks and inspections would you make during and after fitting a new armature unit to a rotating armature magneto ?

SPECIMEN

AIR REGISTRATION BOARD

Aircraft Maintenance Engineers' Licences
Written Examination CATEGORY "X"
(Variable Pitch Propellers)

1. Describe the duties of a Licensed Engineer, in category "X" "V.P." Propellers.
2. Explain how you would prepare an inspection report on the condition of a propeller stripped down for complete overhaul.
3. State approved repair schemes which are applicable to the rectification and overhaul of propeller and C.S.U. component parts.
4. What are the inspectional checks which are carried out on spinners and cooling fans ? How are these components balanced ? What type of repairs are allowed on them ?
5. State from what materials the following are manufactured, and how they are protected against corrosion :
   Spinners, Cooling fans, De-icer slinger rings.
6. State how you would carry out a blade similarity check and explain the application of the 30′, 24′ and 6′ tolerances allowed on 4 bladed propellers.

7. Describe (if necessary by sketch) the methods of gear pre-load on both the high pressure, and low pressure barrel type propellers ; why is pre-loading necessary ?
8. Describe the exact operation (by sketch if required) of the Double Acting type C.S.U., making special note on the operation of the dump valve.
9. Describe the function of three different types of propellers. State types.
10. Make out a list of all special tools, necessary for the complete dismantling of a propeller.
11. Describe the methods used for cleaning the following : Steel parts ; Aluminium alloys ; Magnesium alloys.
12. What are the methods used and the tolerances allowed for the straightening of blades ?
13. (*a*) During the dismantling of a propeller, which has been in service for a long time, describe what faults you are likely to encounter on inspection of the component parts.
(*b*) State what effect those faults are likely to have on the proper functioning of the propeller.
14. Describe what type of protective finishes are used on component parts ; and what methods are used to ascertain satisfactory finishes.
15. Describe what inspections for wear, mal-alignment, and distortion you would make on the following : Barrels, piston and cam assemblies, spiders and stub arms.
16. Assemble a complete propeller, stating all checks and adjustments, making special note on tongue loadings, balancing and pre-loadings. Give all tolerances. State type.
17. What major causes would you suspect for the following :
(*a*) Failure of a propeller to go from *fine* to *coarse* pitch.
(*b*) Failure of a propeller to go from feather to unfeather.
18. What inspections and precautions would you observe during the fitment of a propeller on to the engine shaft ?

SPECIMEN

AIR REGISTRATION BOARD

Aircraft Maintenance Engineers' Licences

Written Examination — CATEGORY "X"

(Instruments—Mechanical)

1. Describe briefly the duties and responsibilities of an Aircraft Engineer Licensed in Category "X" Instruments.
2. Detail the following :—
The I.C.A.N Law.
The Isothermal Law.
Standard Conditions.
London Laboratory Conditions.

3. Sketch and describe :—
   (*a*) A Sensitive Altimeter. (*b*) A Simple Altimeter.
   (*c*) Show where typical adjustments are made on both types. Detail the important differences between the two.
4. Describe the equipment necessary for overhauling and testing:— Sensitive Altimeters.
   Detail briefly the procedure of overhaul, testing and calibrating. State the permissible tolerances (both types).
5. Sketch an A.S.I. mechanism with which you are familiar. Show where adjustments are made and method of application. Detail where temperature compensations are fitted.
6. In connection with A.S.I.'s state what you know about the "Square Law". Is any correction necessary for this, if so, explain how this is generally effected ?
7. Sketch and describe any type of mechanical :—
   (*a*) Engine speed indicator which you know.
   (*b*) Show where adjustments are made.
   (*c*) Detail the overhaul calibration and testing of same.
   (*d*) State the equipment necessary for carrying out the above checks and tests.
   (*e*) State the permissible tolerances.
8. (*a*) Explain the construction and operation of a Bourdon Tube Gauge.
   (*b*) Describe the differences in construction between Low and High pressure types.
   (*c*) Show in a sketch where adjustments may be made.
   (*d*) Detail overhaul inspection checks.
9. Sketch a typical Boost gauge mechanism non fuel proof type. List the equipment necessary for overhaul, calibration and test of boost gauges.
10. Sketch any type of fuel proof boost gauge which you know. State the calibration tolerances and describe briefly the operation of the mechanism.
11. Describe (*a*) Direct Transmitting Capillary type of Air Thermometer.
    (*b*) Direct Transmitting Capillary type of Coolant Thermometer.
    Describe their operational and constructional differences. State tolerances.
12. Sketch and describe a type of Luminisity Comparator with which you are familiar. Detail how it is used.
13. Detail the differences between a "Kew" and "Fortin" Barometer. Describe the corrections necessary to a Barometer. State how they are applied and any one method with which you are familiar.
14. Sketch and describe a Dead weight tester and how it is used in the calibration of gauges.

15. Detail the differences between " Sub-standard ", " Standard " and " Master Standard " test equipment.
16. (*a*) Sketch and describe a turn and slip indicator.
    (*b*) Detail the principle of operation.
    (*c*) State the tolerances after overhaul.
17. Sketch the internal mechanism (Simple sketch) of a Direction Indicator.
18. Detail the tests after overhaul and inspection on an Artificial Horizon.
19. Sketch a typical temperature compensation on an Artificial Horizon and/or Direction Indicator.
20. Detail the method to be employed when testing a D.G. after overhaul. State tolerances.

SPECIMEN

AIR REGISTRATION BOARD

Aircraft Maintenance Engineers' Licences

Written Examination

CATEGORY " X "
(Extension of " X " Licence Instruments to include Electrical Instruments)

1. Define : Volt, Ohm, Capacity, Millivolt, Amp., Watt, E.m.f., Megohm, P.D.
2. Sketch and describe the principle of Wheatstone's Bridge and its application to aircraft instruments.
3. Sketch and describe the construction of moving coil instruments. Detail the differences between (*a*) Voltmeter.
   (*b*) Ammeter.
4. Sketch (*a*) Rheostat.
   (*b*) Potentiometer.
   Describe their uses.
5. Describe (and sketch if necessary) the construction of an A.C. Engine speed indicator and its principle of operation.
6. Detail the Equipment necessary and the method of overhaul of any type of A.C. E.S.I. with which you are familiar.
   Detail the method of Calibration and Equipment to be used.
   State permissible tolerances.
7. Detail the main differences between the following and show by sketch the circuits.
   Desynn System
   Selsyn System
   Auto syn System
   Telegon System.
8. Describe the operation of a Fuel Meter, and the method of calibration.

9. Give a diagrammatic sketch of a Ratiometer.
   State what advantages this type of instrument has over the Wheatstone Bridge type.
10. Draw the electrical circuit of a Stroboscope.

SPECIMEN

AIR REGISTRATION BOARD

Aircraft Maintenance Engineers' Licences
Written Examination

CATEGORY "X"
(Electrical Equipment—
Not exceeding 30 Volts)

1. Briefly describe the duties of a Licensed Aircraft Engineer in Category "X" (Electrical).
2. Define the following : Ohms ; Inductance ; Watt Hour, Di-electric ; P.D. ; E.m.f.
3. Detail the advantages and disadvantages and state what type of accumulator is used in aircraft : Nickel-cadmium alkaline ; Lead acid.
4. Describe a Function Test on an Aircraft Electrical Service.
5. In what sequence should the following be carried out : Functioning, Inspection, Insulation, Continuity ?
6. Give the names of four types of Voltage Control.
7. What is the "Kick" method ? What is its use ? Describe how it is carried out.
8. Detail how Bonding Testing should be carried out.
9. Define Faraday's law of Induction.
10. Explain how you would set the brush position on (*a*) an Electrical Motor ; (*b*) Generator ; when not known.
11. Shew by sketch any type of Voltage Control with which you are familiar.
12. State to what is Fleming's Right Hand Rule applied ?
    " Left Hand Rule applied ?
13. What is Lenz's Law ?
14. Describe a battery test prior to installation in an aircraft.
15. Describe what equipment you think is necessary for an accumulator charging room. What type of building is preferred, and what important precautions should be taken ?
16. Give several examples of aircraft cables. Explain cable rating. State what flux and solder should be used.
17. Detail an inspection and overhaul on Fuse Box and Fuse.
18. What is the resistance of 4, 6 and 8 ohms in parallel ?
19. Explain the mechanical checks to be made on a stripped generator.
20. Show by a suitable sketch how you would connect 6 × 12 volt accumulators to provide a 24-volt supply.

VI

Syllabus of Examination

This Chapter consists of a reproduction of Chapters L1-3 to L1-15 of Section "L", British Civil Airworthiness Requirements.

It will be noted that the first item of each syllabus refers to British Civil Airworthiness Requirements so far as they affect an aircraft maintenance engineer licensed in the particular category. In the past the aircraft engineer may have been in doubt as to how far British Civil Airworthiness Requirements affected him. To remove this doubt and to make know the Air Registration Board's recommendations relating to inspection duties in connection with the various aspects of the construction, overhaul, repair and maintenance of civil aircraft, the A.R.B. has recently commenced publication of a series of leaflets under the title of "Civil Aircraft Inspection Procedures". Any mandatory inspection procedures will remain in British Civil Airworthiness Requirements but, when this is done, the fact will be indicated in Civil Aircraft Inspection Procedures.

The Inspection Procedures* also contain information on recommended practices related to workshop methods, processes and servicing and information considered essential to the proper understanding of the procedures. The degree of useful application of the Inspection Procedures and their interpretation is dependent on the background of knowledge held by the user. The information is essentially of a general character and no detailed guidance is included on specific types of airframes, engines or specialised equipment. The appropriate manufacturers' publications should be read in conjunction with the Inspection Procedures.

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* The Inspection Procedures are obtainable as separate leaflets at the cost of 4d. each, post free, but those persons desirous of receiving the leaflets as and when they are issued or re-issued may open a deposit account with the A.R.B., the minimum amount for the deposit being £1. Further particulars of this scheme may be obtained from the A.R.B. Folders in which to keep the leaflets are also obtainable from the A.R.B. at a cost of 9/6 each, post free.

CHAPTER L 1—3

GRANT AND EXTENSION—CATEGORY "A"

(AEROPLANES)

NOTE: Wherever the term "Notice No. 10" is used in this Chapter, it refers to the current issue of Notice to Licensed Aircraft Engineers and to Owners of Civil Aircraft No. 10.

1.—EXPERIENCE REQUIRED. Applicants for the GRANT of a licence in Category "A", the ADDITION of Category "A" to an existing licence, and the EXTENSION of a licence already valid in Category "A", will be required to furnish particulars of their experience, and this must include the full minimum experience as shown on pages 45 and 46 of maintenance and/or inspection of aeroplanes prior to flight.

GRANT OR ADDITION OF CATEGORY "A"

Applications for aeroplanes will be accepted for only one of the following :—	All or any of the types specified in paragraph 5.1 of Notice No. 10 (i.e. single-engined types of wooden construction).		OR	All or any of the types specified in paragraph 5.2 of Notice No. 10 (i.e. single-engined types of composite or all metal fabric covered construction).		OR	One of the types specified in paragraph 5.3 of Notice No. 10.		OR	One of the types specified in paragraph 5.4 of Notice No. 10		OR	One of the types specified in paragraph 5.5 of Notice No. 10.
	Without Approved Course	With Ministry of Civil Aviation Approved Course		Without Approved Course	With Ministry of Civil Aviation Approved Course		Without Approved Course	With Ministry of Civil Aviation Approved Course		Without Approved Course	With Ministry of Civil Aviation Approved Course	For experience of types in paragraph 5.5 see Notice No. 10. See also Special Note below.
Total aeronautical engineering experience, **periods totalling :—**	3 years	2 years		3 years	2 years		3 years	2 years		3 years	2 years	
AND this must include general practical maintenance and/or inspection solely of airframes prior to flight, **periods totalling :—**	12 months	6 months		12 months	6 months		18 months	12 months		24 months	18 months	
AND of this, **periods totalling :—** must have been on the practical maintenance and/or inspection prior to flight on type(s) for which application is made (or one of similar characteristics and a satisfactory course on the type).	6 months	6 months		6 months	6 months		6 months	6 months		12 months	12 months	
										See Special Note below.		

DEFINITION : A Ministry of Civil Aviation Approved Course for this Category is one which includes training in the maintenance of airframes.

SPECIAL NOTE : For types of Aircraft of an all-up weight of or exceeding 80,000 lb. the experience required will be the same as stated for types specified in paragraph 5.4 of Notice No. 10, except that, in addition, the applicant must have had practical maintenance experience of types of approximately comparable all-up weight.

EXTENSION IN CATEGORY "A"

Types of Aeroplanes	All or any of the types specified in paragraph 5.1 of Notice No. 10 (i.e. single-engined types of wooden construction).	**OR**	All or any of the types specified in paragraph 5.2 of Notice No. 10 (i.e. single-engined types of composite or all metal fabric covered construction).	**OR**	All or any of the types specified in paragraph 5.3 of Notice No. 10.	**OR**	All or any of the types specified in paragraph 5.4 of Notice No. 10.	**OR**	All or any of the types specified in paragraph 5.5 of Notice No. 10.
Experience of practical maintenance and/or inspection of airframes prior to flight.	Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "A" for a type specified in this paragraph, when satisfactory evidence of recent experience or a recent satisfactory course on the type(s) for which application is made, may be accepted.		Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "A" for a type specified in this paragraph, when satisfactory evidence of recent experience or a recent satisfactory course on the type(s) for which application is made, may be accepted.		Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "A" for a type specified in this paragraph, when satisfactory evidence of recent experience or a recent satisfactory course on the type(s) for which application is made, may be accepted.		Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "A" for a type specified in this paragraph, when satisfactory evidence of recent experience or a recent satisfactory course on the type(s) for which application is made, may be accepted. See Special Note below		For experience of types in paragraph 5.5 see Notice No. 10. See also Special Note below.

SPECIAL NOTE : For types of aircraft of an all-up weight of or exceeding 80,000 lb. the experience required will be the same as stated for types specified in paragraph 5.4 of Notice No. 10, except that, in addition, the applicant must have had practical maintenance experience of types of approximately comparable all-up weight.

2.—Applicants accepted for a licence in Category "A" will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraphs 3.1 to 3.20 according to the construction of the type(s) for which accepted.

3.—SYLLABUS.

3.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Category "A".

3.2 Practical arithmetical calculations, involving vulgar and decimal fractions, percentages and mensuration.

3.3 The various terms used in aeroplane construction and aerodynamics, and the functioning of each component part of an aeroplane.

3.4 The preparation of a brief report, illustrated by sketches if necessary, describing the replacements required in the event of damage, defect or wear.

3.5 The inspection and checks for alignment after assembly of aeroplane structural components.

3.6 The inspection during and after adjustment of flying controls.

3.7 The correction of faults experienced in flight with particular reference to rigging and control settings.

3.8 General maintenance (including equipment) and minor repairs.

3.9 Defects and deterioration of metallic materials, treatments and methods used against corrosion.

3.10 Defects and deterioration of wooden structures, including treatments and methods used in connection with them, where applicable.

3.11 Defects and deterioration of materials—other than wood or metal—including fabric, dopes, etc. Treatments and methods used in rectifying defects encountered, where applicable.

3.12 The inspection of control mechanisms for defects and deterioration.

3.13 The inspection and scope of investigation following heavy landings.

3.14 The methods of checking flying instruments for correct functioning, the inspection of instruments and instrument installations in aeroplanes, and methods of making check calibrations.

3.15 The inspection of electrical installations in aeroplanes and testing for correct functioning and condition.

3.16 The inspection of undercarriage shock-absorbing legs, brakes, wheels and tyres.

3.17 The principles of operation of retracting undercarriage and flap operating systems and inspection of these systems installed in aeroplanes, where applicable.

3.18 Where applicable, general principles of operation of the particular type of automatic pilot installed in the aeroplane(s).

3.19 Where applicable, methods of coupling the automatic pilot system to the aircraft flying controls. Tests to ensure that the automatic pilot can be immediately disengaged and/or overcontrolled in any emergency.

3.20 Where applicable, the daily maintenance and periodical inspections necessary to ensure correct operation and functioning of automatic pilot installations. Such minor replacements and adjustments on the aeroplane as specified in the maintenance manual as being within the scope of an aircraft engineer "M" licensed in Category "A".

4.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in paragraph 3 above, and in all cases shall demonstrate in this examination:—

4.1 Their practical knowledge of inspection and the use of measuring instruments and the interpretation of drawings.

4.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations, so far as they affect an aircraft engineer "M" licensed in Category "A".

CHAPTER L 1—4

GRANT AND EXTENSION—CATEGORY "A"

(GLIDERS)

1.—Applicants for the grant of a licence in Category "A" (Gliders), of a maximum authorised all-up weight of 1,200 lb. or less, shall have had experience satisfactory to the Board in the general practical maintenance of Primary and Secondary Gliders, or airframes similar in construction to the types of gliders for which application is made.

2.—Applicants accepted for a licence in Category "A" will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraphs 3.1 to 3.17 according to the construction of the type(s) for which accepted.

3.—SYLLABUS.

3.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Category "A".

3.2 Practical arithmetical calculations, involving vulgar and decimal fractions, percentages and mensuration.

3.3 General maintenance (including equipment) and minor repairs.

3.4 The various terms used in glider construction and aerodynamics and the functioning of each component part of a glider.

3.5 The inspection and checks for alignment after assembly of the glider structural components.

3.6 The inspection during and after adjustment of flying controls.

3.7 The correction of faults experienced in flight with particular reference to rigging and control settings.

3.8 The installation and functioning of electrical services, where applicable.

3.9 Defects and deterioration of metallic materials, treatments and methods used against corrosion.

3.10 Defects and deterioration of wooden structures, including treatments and methods used in connection with them.

3.11 Defects and deterioration of materials—other than wood or metal—including fabric, dopes, etc. Treatments and methods used in rectifying defects encountered, where applicable.

3.12 The principles and functioning of shock-absorbing devices and, where applicable, retracting devices of landing gear.

3.13 The methods of inspection of aero-tow ropes and quick-release devices.

3.14 The inspection of control mechanism for defects and deterioration.

3.15 The inspection and scope of investigation following heavy landings.

3.16 The methods of checking flying instruments for correct functioning, the inspection of instruments and instrument installations in gliders, and methods of making check calibrations.

3.17 The preparation of a brief report, illustrated by sketches if necessary, describing the replacements required in the event of damage, defect or wear.

4.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in paragraph 3 above, and in all cases shall demonstrate in this examination:—

4.1 Their practical knowledge of inspection and the use of measuring instruments and the interpretation of drawings.

4.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations, so far as they affect an aircraft engineer "M" licensed in Category "A".

CHAPTER L 1—5

GRANT AND EXTENSION—CATEGORY "B"

(AEROPLANES)

NOTE: Wherever the term "Notice No. 10" is used in this Chapter, it it refers to the current issue of Notice to Licensed Aircraft Engineers and to Owners of Civil Aircraft No. 10.

1.—EXPERIENCE REQUIRED. Applicants for the certification of the repair and overhaul of aeroplanes, incorporating the use and replacement of approved parts only, for the GRANT of a licence in Category "B", the ADDITION of Category "B" to an existing licence, and the EXTENSION of a licence already valid in Category "B", will be required to furnish particulars of their experience and this must include the full minimum experience as shown on pages 51 and 52 of overhaul and/or repair of aeroplanes.

2.—Where the licence is required to include the certification of the construction of parts and of materials used therefor, applicants shall in addition have had a minimum of two years' experience of the inspection of the fabrication of materials into aeroplane parts, components and complete aeroplanes. At least one year of this experience must have been spent in the identification, selection, inspection and physical testing of materials involved, the heat treatment of metals and the various processes for the protection of materials, parts and assemblies against corrosion applicable to the type(s) for which application is made.

GRANT OR ADDITION OF CATEGORY "B"

Applications for aeroplanes will be accepted for only one of the following :—	All or any of the types specified in paragraph 5.1 of Notice No. 10 (i.e. single-engined types of wooden construction).		**OR** All or any of the types specified in paragraph 5.2 of Notice No. 10 (i.e. single-engined types of composite or all metal fabric covered construction).		**OR** One of the types specified in paragraph 5.3 of Notice No. 10.		**OR** One of the types specified in paragraph 5.4 of Notice No. 10		**OR** One of the types specified in paragraph 5.5 of Notice No. 10.
	Without Approved Course	With Ministry of Civil Aviation Approved Course	Without Approved Course	With Ministry of Civil Aviation Approved Course	Without Approved Course	With Ministry of Civil Aviation Approved Course	Without Approved Course	With Ministry of Civil Aviation Approved Course	For experience of types in paragraph 5.5 see Notice No. 10. See also Special Note below.
Total aeronautical engineering experience, **periods totalling :—**	3 years	2 years	3 years	2 years	3 years	2 years	3 years	2 years	
AND this must include experience of general practical overhaul and/or repair solely of airframes, **periods totalling :—**	12 months	6 months	12 months	6 months	18 months	12 months	24 months	18 months	
AND of this, **periods totalling :—** must have been practical overhaul and/or repair experience of type(s) for which application is made (or one of similar characteristics and a satisfactory course on the type).	6 months	6 months	6 months	6 months	6 months	6 months	12 months	12 months	
							See Special Note below.		

DEFINITION : A Ministry of Civil Aviation Approved Course for this Category is one which includes training in the overhaul and repair of airframes.

SPECIAL NOTE : For types of aircraft of an all-up weight of or exceeding 80,000 lb. the experience required will be the same as stated for types specified in paragraph 5.4 of Notice No. 10, except that, in addition, the applicant must have had practical overhaul and repair experience of types of approximately comparable all-up weight.

EXTENSION IN CATEGORY "B"

Types of Aeroplanes	All or any of the types specified in paragraph 5.1 of Notice No. 10 (i.e. single-engined types of wooden construction).	OR	All or any of the types specified in paragraph 5.2 of Notice No. 10 (i.e. single-engined types of composite or all metal fabric covered construction).	OR	All or any of the types specified in paragraph 5.3 of Notice No. 10.	OR	All or any of the types specified in paragraph 5.4 of Notice No. 10.	OR	All or any of the types specified in paragraph 5.5 of Notice No. 10.
Experience of practical overhaul and/or repair of airframes.	Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "B" for a type specified in this paragraph, when satisfactory evidence of recent experience or a recent satisfactory course on the type(s) for which application is made, may be accepted.		Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "B" for a type specified in this paragraph, when satisfactory evidence of recent experience or a recent satisfactory course on the type(s) for which application is made, may be accepted.		Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "B" for a type specified in this paragraph, when satisfactory evidence of recent experience or a recent satisfactory course on the type(s) for which application is made, may be accepted.		Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "B" for a type specified in this paragraph, when satisfactory evidence of recent experience or a recent satisfactory course on the type(s) for which application is made, may be accepted. See Special Note below		For experience of types in paragraph 5.5 see Notice No. 10. See also Special Note below.

SPECIAL NOTE : For types of an all-up weight of or exceeding 80,000 lb. the experience required will be the same as stated for types specified in paragraph 5.4 of Notice No. 10, except that, in addition, the applicant must have had practical overhaul and repair experience of types of approximately comparable all-up weight.

3.—**Applicants accepted for a licence in Category "B" for certification of the overhaul and repair of aeroplanes incorporating the replacement of approved parts and components only, will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraphs 5.1 to 5.17 according to the construction of the type(s) for which accepted.**

4.—Applicants accepted for a licence in Category "B" for certification of the overhaul and repair of aeroplanes including the certification of the construction of components and parts and the materials used therefor, will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects referred to in paragraph 3 above and in addition, will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraphs 5.18 to 5.23 according to the construction of the type(s) for which accepted.

5.—SYLLABUS.

5.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Category "B".

5.2 Practical arithmetical calculations, involving vulgar and decimal fractions, percentages and mensuration.

5.3 The various terms used in aeroplane construction and aerodynamics and the functioning of each component part of an aeroplane.

5.4 The preparation of an inspection report on the condition of an aeroplane that is about to be overhauled for the renewal of the certificate of airworthiness.

5.5 The method of systematically carrying out the required overhaul.

5.6 The procedure for completing the inspection record on work done for the purpose of overhaul of the component parts.

5.7 The approved repair schemes applicable to the complete rectification and overhaul of the component parts.

5.8 The inspection of the repair, overhaul and assembly of components and the workshop processes involved, such as glueing, doping, welding, brazing and soldering, so far as they affect the incorporation of previously approved replacement members and parts, including the appropriate protective treatments, where applicable.

5.9 The inspection and methods of checking for alignment and symmetry of components such as fuselages, hulls, floats, wings and fixed-pitch propellers, where applicable.

5.10 The inspection of the repair, overhaul and functional testing of tanks, radiators and coolers.

5.11 The inspection of the repair, overhaul and functional testing of shock-absorbing devices of landing gear.

5.12 The inspection of engine installations, including controls and fuel, oil and coolant systems.

5.13 The inspection of the complete aeroplane, including controls and trimming devices, for correct assembly and functioning.

5.14 The general principles of electricity and magnetism and, as far as it is practicable on the ground, the inspection of the installation and functioning of instruments, automatic pilots and electrical equipment. Methods of making check calibrations.

5.15 The method of determining the weight and the position of the centre of gravity of an aeroplane and the preparation of the weight schedule.

5.16 The preparation of a sketch from which a finished drawing can be made.

5.17 The inspection of the assembly and functioning of retracting devices of landing gear, where applicable.

5.18 The identification, selection, inspection and physical testing of the various timbers used in the construction of the aeroplane, where applicable.

5.19 The methods of examination and physical testing of all the non-metallic materials (other than timbers) used in the construction of the aeroplane to ensure compliance with specification requirements.

5.20 The inspection during fabrication of non-metallic materials into aeroplane parts and components of the workshop processes involved, glueing, stitching, doping and protective measures against corrosion and deterioration, where applicable.

5.21 The methods of examination and physical testing of both ferrous and non-ferrous metallic materials used in the construction of the aeroplane, to ensure compliance with specification requirements.

5.22 The inspection during fabrication of metallic materials into aeroplane parts and components, and of the workshop processes involved. Heat treatment including temperature control, welding, soldering, brazing, electro-plating and other protective treatments against corrosion and deterioration.

5.23 The inspection during construction of components such as fuselages, wings, fixed-pitch propellers, tanks, radiators and coolers.

6.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in paragraphs 5.1 to 5.23 above, as applicable, and in all cases shall demonstrate in this examination:—

6.1 Their practical knowledge of inspection, the use of measuring instruments and the interpretation of drawings.

6.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations, so far as they affect an aircraft engineer "M" licensed in Category "B".

CHAPTER L 1—6

GRANT AND EXTENSION—CATEGORY "B"

(GLIDERS)

1.—Applicants for the grant of a licence in Category "B" (Gliders), of a maximum authorised all-up weight of 1,200 lb. or less, shall have had general experience satisfactory to the Board in the construction and/or overhaul or repair of Primary and Secondary Gliders or airframes of similar construction to the type(s) of gliders for which application is made.

2.—Where the licence is required to include the certification of the construction of parts and of the materials used therefor, applicants shall in addition have had a minimum of two years' experience of the inspection of the fabrication of materials into glider parts, components and complete gliders. At least one year of this experience must have been spent in the identification, selection, inspection and physical testing of materials involved, the heat treatment of metals and the various processes for the protection of materials, parts and assemblies against corrosion applicable to the type(s) for which application is made.

3.—**Applicants accepted for a licence in Category "B" for certification of the overhaul and repair of gliders, incorporating the replacement of approved parts and components only, will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraphs 5.1 to 5.15 according to the construction of the type(s) for which accepted.**

4.—Applicants accepted for a licence in Category "B" for the certification of the overhaul and repair of gliders, including the certification of the construction of components and parts and the materials used therefor, will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects referred to in paragraph 3 above and, in addition, will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraphs 5.16 to 5.21 according to the construction of the type(s) for which accepted.

5.—SYLLABUS

5.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Category "B".

5.2 Practical arithmetical calculations, involving vulgar and decimal fractions, percentages and mensuration.

5.3 The various terms used in glider construction and aerodynamics, and the functioning of each component part of a glider.

5.4 The preparation of an inspection report on the condition of a glider that is about to be overhauled for the renewal of the certificate of airworthiness.

5.5 The method of systematically carrying out the required overhaul.

5.6 The procedure for completing the inspection record on work done for the purpose of overhaul of the component parts.

5.7 The approved repair schemes applicable to the complete rectification and overhaul of the component parts.

5.8 The inspection of the repair, overhaul and assembly of components and the workshop processes involved, such as glueing, doping, welding, brazing and soldering so far as they affect the incorporation of previously approved replacement members and parts, including the appropriate protective treatments, where applicable.

5.9 The inspection and methods of checking the alignment of components such as fuselages, wings and tail-planes.

5.10 The construction, functioning, repair and overhaul of shock-absorbing devices, and where applicable, retracting devices of landing gear.

5.11 The methods of inspection of aero-tow ropes and quick release devices.

5.12 The inspection of a complete glider, including controls and trimming devices, for correct assembly.

5.13 The inspection, functioning and check calibration of instruments, and testing of electrical services, where applicable.

5.14 The method of determining the weight and the position of the centre of gravity of a glider, and the preparation of a weight schedule.

5.15 The preparation of a sketch from which a finished drawing can be made.

5.16 The identification, selection, inspection and physical testing of the various timbers used in the construction of the glider.

5.17 The methods of examination and physical testing of all the non-metallic materials (other than timbers) used in the construction of the glider to ensure compliance with specification requirements.

5.18 The inspection during fabrication of non-metallic materials into glider parts and components, of the workshop processes involved, glueing, stitching, doping and protective measures against corrosion and deterioration, where applicable.

5.19 The methods of examination and physical testing of both ferrous and non-ferrous metallic materials used in the construction of the glider, to ensure compliance with the specification requirements.

5.20 The inspection during fabrication of metallic materials into glider parts and components, and of the workshop processes involved. Heat treatment including temperature control, welding, soldering, brazing, electro-plating and other protective treatments against corrosion and deterioration.

5.21 The inspection during construction of components such as fuselages, wings and tail-planes.

6.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in paragraphs 5.1 to 5.21 above, as applicable, and in all cases shall demonstrate in this examination:—

6.1 Their practical knowledge of inspection, the use of measuring instruments and the interpretation of drawings.

6.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations, so far as they affect an aircraft engineer "M" licensed in Category "B".

CHAPTER L 1—7

GRANT AND EXTENSION—CATEGORY "C"

(ENGINES)

NOTE: Wherever the term "Notice No. 10" is used in this Chapter, it refers to the current issue of Notice to Licensed Aircraft Engineers and to Owners of Civil Aircraft No. 10.

1.—EXPERIENCE REQUIRED. Applicants for the GRANT of a licence in Category "C", the ADDITION of Category "C" to an existing licence, and the EXTENSION of a licence already valid in Category "C", will be required to furnish particulars of their experience and this must include the full minimum experience as shown on pages 59 and 60 of maintenance and/or inspection of engines prior to flight.

2.—Applicants accepted for a licence in Category "C" will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraphs 3.1 and 3.2 for piston engines and 3.1 and 3.3 for turbo-jet and/or turbo-propeller engines, according to the type(s) for which accepted.

3.—SYLLABUS

3.1 GENERAL.

3.1.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Category "C".

3.1.2 Practical arithmetical calculations involving vulgar and decimal fractions, percentages and mensuration.

3.1.3 The preparation of a brief report, illustrated by sketches if necessary, describing the replacements required in the event of damage, defect or wear.

3.1.4 Methods of inspection for defects during rectification, clearances and allowances for wear and distortion.

3.1.5 Methods of rectification of defects, inspection during and after re-assembly.

GRANT OR ADDITION OF CATEGORY "C"

Applications for engines will be accepted for only one of the following :—	All or any of the types specified in paragraph 6.1 of Notice No. 10 (i.e. unsupercharged with fixed - pitch propellers).		**OR** One of the types specified in paragraph 6.2 of Notice No. 10 (i.e. supercharged with variable-pitch propellers and supercharged with fixed-pitch propellers).		**OR** One of the types specified in paragraph 6.3 of Notice No. 10 (i.e. supercharged with variable - pitch propellers).		**OR** One of the types specified in paragraph 6.4 of Notice No. 10.	NOTE : The requirements in respect of turbine engines are at present issued for information only and the Board will indicate when applications for the types of engines can be considered.			
								OR One type of turbo-jet		**OR** One type of turbo propeller	
	Without Approved Course	With Ministry of Civil Aviation Approved Course	Without Approved Course	With Ministry of Civil Aviation Approved Course	Without Approved Course	With Ministry of Civil Aviation Approved Course		Without Approved Course	With Ministry of Civil Aviation Approved Course	Without Approved Course	With Ministry of Civil Aviation Approved Course
Total engineering experience, **periods totalling** :—	3 years	2 years	3 years	2 years	3 years	2 years	For experience of types in paragraph 6.4 see Notice No. 10 See also Special Note below.	3 years	2 years	3 years	2 years
AND this must include general practical maintenance and/or inspection solely of engines prior to flight, **periods totalling** :—	12 months	6 months	18 months	12 months	24 months	18 months		18 months	12 months	24 months	18 months
AND of this, **periods totalling** :— must have been on the practical maintenance and/or inspection prior to flight on type(s) for which application is made (or one of similiar characteristics and a satisfactory course on the type).	6 months	6 months	6 months	6 months	12 months	12 months		6 months	6 months	12 months	12 months
					See Special Note below.						

DEFINITION : A Ministry of Civil Aviation Approved Course for this Category is one which includes training in the maintenance of engines in airframes and, with the exception of turbo-jet engines, must also include maintenance of propellers.

SPECIAL NOTE : For types of piston engines of, or exceeding 2,000 b.h.p. the experience required will be the same as stated for types specified in paragraph 6.3 of Notice No. 10, except that, in addition, the applicant must have had practical maintenance experience of types of approximately comparable horse-power.

EXTENSION IN CATEGORY "C"

Types of Engines	All or any of the types specified in paragraph 6.1 of Notice No. 10 (i.e. unsupercharged with fixed-pitch propellers).	OR	All or any of the types specified in paragraph 6.2 of Notice No. 10 (i.e. unsupercharged with variable-pitch propellers and supercharged with fixed-pitch propellers).	OR	All or any of the types specified in paragraph 6.3 of Notice No. 10 (i.e. supercharged with variable-pitch propellers).	OR	All or any of the types specified in paragraph 6.4 of Notice No. 10.	OR	NOTE : The requirements in respect of turbine engines are at present issued for information only and the Board will indicate when applications for these types of engines can be considered. Turbo-jet engines	OR	Turbo-propeller engines
Experience of practical maintenance and/or inspection of engines prior to flight.	Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "C" for a type specified in this paragraph, when satisfactory evidence of recent experienceorarecent satisfactory course on the type(s) for which applicationismade, may be accepted.		Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "C" for a type specified in this paragraph, when satisfactory evidence of recent experienceorarecent satisfactory course on the type(s) for which applicationismade, may be accepted.		Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "C" for a type specified in this paragraph, when satisfactory evidence of recent experienceorarecent satisfactory course on the type(s) for which applicationismade, may be accepted. See Special Note below.		For experience of types in paragraph 6.4 see Notice No. 10. See also Special Note below.		(i) **If existing Category is valid only in respect of piston engines.** Periods totalling 9 months spent solely on the maintenance of turbo-jet engines. 6 months of this total period must have been spent solely on the maintenance of the type of engine for which application is made. If, however, the applicant has completed, to the satisfaction of the Board, a recent manufacturer's course on the type of engine for which application is made, the experience required may be reduced to 6 months, all of which must have been on the maintenance of the type of engine for which application is made. (ii) **If existing Category is already valid for turbo-jet or turbo-propeller engines.** Satisfactory evidence of recent experience or a recent satisfactory manufacturer's course on the type for which application is made may be accepted. (Applications may be accepted for more than one type).		(i) **If existing Category is valid only in respect of piston engines.** Periods totalling 12 months spent solely on the maintenance of turbo-propeller engines. 6 months of this total period must have been spent solely on the maintenance of the type of engine for which application is made. If, however, the applicant has completed, to the satisfaction of the Board, a recent manufacturer's course (which must include the propeller unit) on the type of engine for which application is made, the experience required may be reduced to 6 months, all of which must have been on the maintenance of the type of engine for which application is made. (ii) **If the existing licence is already valid for turbo-jet engines.** Experience required may be reduced to 3 months, all of which must have been on the maintenance of the type of engine for which application is made. (iii) **If existing Category is already valid for turbo-propeller engines.** Satisfactory evidence of recent experience or a recent satisfactory manufacturer's course on the type for which application is made may be accepted. (Applications may be accepted for more than one type).

SPECIAL NOTE : For types of piston engines of, or exceeding, 2,000 b.h.p. the experience required will be the same as stated for types specified in paragraph 6.3 of Notice No. 10, except that, in addition, the applicant must have had practical maintenance experience of types of approximately comparable horse-power.

3.1.6 Inspection and checks on complete installation and systems, as required during engine installation.

3.1.7 The methods of checking engine instruments for correct functioning, the inspection of engine instruments and instrument installations in aeroplanes, and methods of making check calibrations.

3.1.8 Testing and tuning during ground running in accordance with the manufacturer's recommended procedure, including diagnosis of all types of running faults.

3.1.9 Preparing engines for initial installation and inhibiting after removal; inspection during daily maintenance and periodical servicing.

3.1.10 Where applicable, the assembly of variable-pitch propellers dismantled for ease of transport, assembly of propeller to engine, inspection of damage to propellers, permissible limits and methods of rectification.

3.1.11 Where applicable, the principles of operation of variable-pitch propellers and controlling devices; inspection of correct assembly and functioning; ground testing and rectification of defects.

3.2 PISTON ENGINES.

3.2.1 The principles of operation of piston engines and the general construction of current type(s) of engines for which accepted.

3.2.2. Constructional details of parts the rectification of which may be certified by the holder of a licence in Category " C ".

3.2.3 Typical running faults and defects calling for partial overhaul or other rectification which may be certified by the holder of a licence in Category " C ".

3.2.4 The principles, arrangement and inspection of the complete fuel, oil (and coolant, where applicable) systems, and tests for functioning and defects and methods of rectification.

3.2.5 Inspection of ignition systems for correct installation, condition, timing and functioning, and tests for defects and methods of rectification.

3.2.6 The principles of operation of carburettors and/or injectors; inspection of carburettors and/or injectors, controls and induction systems; tests for functioning and defects.

3.2.7 Where applicable, the inspection of fixed-pitch propellers and checks during assembly to engine.

3.2.8 Where applicable, the principle of supercharging and the operation of boost controls; inspection for correct assembly, adjustment and functioning.

3.3 TURBO-JET AND TURBO-PROPELLER ENGINES.

3.3.1 The principles of operation of turbo-jet and/or turbo-propeller engines and general construction of the current type(s) of engines for which accepted.

3.3.2 The various terms used in the construction of turbine engines and the functioning of each component part of the engine.

3.3.3 The procedure for the partial dismantling and re-assembly of the engine to permit inspection and rectification which may be certified by an engineer licensed in Category " C ".

3.3.4 Construction, functioning and maintenance (including adjustments) of all systems and ancillary devices necessary for the operation of the engine.

3.3.5 The principles of operation of fuel systems and controls, inspection of complete fuel systems and controls and the tests for functioning and defects.

3.3.6 Inspection of ignition systems for correct installation, condition and functioning and tests for defects and methods of rectification.

3.3.7 Principles, arrangement and inspection of the starter panel systems. Testing for functioning defects and methods of rectification.

3.3.8 Construction, functioning and maintenance of the complete starting system.

3.3.9 Knowledge of safety precautions during ground running, parking and storage, and means of protection of breakdown points of fuel systems.

4.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in paragraph 3 above, as applicable, and in all cases shall demonstrate in this examination: —

4.1 Their practical knowledge of inspection and of the use of measuring instruments and the interpretation of drawings.

4.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations, so far as they affect an aircraft engineer " M " licensed in Category " C ".

CHAPTER L 1—8

GRANT AND EXTENSION—CATEGORY "D"

(ENGINES)

NOTE: Wherever the term "Notice No. 10" is used in this Chapter, it refers to the current issue of Notice to Licensed Aircraft Engineers and to Owners of Civil Aircraft No. 10.

1.—EXPERIENCE REQUIRED. Applicants for the certification of the repair and overhaul of engines, incorporating the use and replacement of approved parts only, for the GRANT of a licence in Category "D", the ADDITION of Category "D" to an existing licence, and the EXTENSION of a licence already valid in Category "D", will be required to furnish particulars of their experience and this must include the full minimum experience as shown on pages 64 and 65 of overhaul and/or repair of engines.

2.—Where the licence is required to include the certification of the construction of parts and of the materials used therefor, applicants shall in addition have had a minimum of two years' experience of the inspection of the fabrication of materials into engine parts, components and complete engines. At least one year of this experience must have been spent in the identification, selection, inspection and physical testing of materials involved, the heat treatment of metals and the various processes for the protection of materials, parts and assemblies against corrosion applicable to the type(s) for which application is made.

3.—**Applicants accepted for a licence in Category "D" for the certification of the overhaul and repair of engines incorporating the replacement of approved parts and components only, will be required to answer, in written examination, questions in respect of the subjects detailed in paragraphs 5.1 to 5.15 according to the construction of the type(s) for which accepted.**

4.—Applicants accepted for a licence in Category "D" for the certification of the overhaul and repair of engines including the certification of the construction of components and parts and the materials used therefor, will be required to answer, in written examination, questions in respect of the subjects referred to in paragraph 3 above and in addition will be required to answer, in written examination, questions in respect of the subjects detailed in paragraphs 5.16 to 5.20 according to the construction of the type(s) for which accepted.

5.—SYLLABUS.

5.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Category "D".

GRANT OR ADDITION OF CATEGORY "D"

Applications for engines will be accepted for only one of the following :—	All or any of the types specified in paragraph 6.1 of Notice No. 10 (i.e. unsupercharged with fixed-pitch propellers).		OR	All or any of the types specified in paragraph 6.2 of Notice No. 10 (i.e. unsupercharged with variable-pitch propellers and supercharged with fixed-pitch propellers).		OR	All or any of the types specified in paragraph 6.3 of Notice No. 10 (i.e. supercharged with variable-pitch propellers).		OR	All or any of the types specified in paragraph 6.4 of Notice No. 10.
	Without Approved Course	With Ministry of Civil Aviation Approved Course		Without Approved Course	With Ministry of Civil Aviation Approved Course		Without Approved Course	With Ministry of Civil Aviation Approved Course		For experience of types in paragraph 6.4 see Notice No. 10. See also Special Note below.
Total engineering experience, **periods totalling :—**	3 years	2 years		3 years	2 years		3 years	2 years		
AND this must include general practical overhaul and/or repair solely of engines, **periods totalling :—**	12 months	6 months		18 months	12 months		24 months	18 months		
AND of this, **periods totalling :—** must have been on the practical overhaul and/or repair on type(s) for which application is made (or one of similar characteristics and a satisfactory course on the type).	6 months	6 months		6 months	6 months		12 months	12 months		
							See Special Note below.			

DEFINITION : A Ministry of Civil Aviation Approved Course for this Category is one which includes training in the complete overhaul of engines.

SPECIAL NOTE : For types of piston engines of, or exceeding, 2,000 b.h.p. the experience required will be the same as stated for types specified in paragraph 6.3 of Notice No. 10, except that, in addition, the applicant must have had practical overhaul experience of types of approximately comparable horse-power.

EXTENSION IN CATEGORY "D"

Types of Engines	All or any of the types specified in paragraph 6.1 of Notice No. 10 (i.e. unsupercharged with fixed-pitch propellers).	**OR**	All or any of the types specified in paragraph 6.2 of Notice No. 10 (i.e. unsupercharged with variable-pitch propellers and supercharged with fixed-pitch propellers).	**OR**	All or any of the types specified in paragraph 6.3 of Notice No. 10 (i.e. supercharged with variable-pitch propellers).	**OR**	All or any of the types specified in paragraph 6.4 of Notice No. 10
Experience of practical overhaul and/or repair of engines.	Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "D" for a type specified in this paragraph, when satisfactory evidence of recent experience or a recent satisfactory course on the type(s) for which application is made, may be accepted.		Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "D" for a type specified in this paragraph, when satisfactory evidence of recent experience or a recent satisfactory course on the type(s) for which application is made, may be accepted.		Periods totalling 6 months spent solely on the type(s) for which extension is desired, UNLESS the licence is already valid in Category "D" for a type specified in this paragraph, when satisfactory evidence of recent experience or a recent satisfactory course on the type(s) for which application is made, may be accepted. See Special Note below.		For experiences of types in paragraph 6.4 see Notice No. 10. See also Special Note below.

SPECIAL NOTE : For types of piston engines of, or exceeding, 2,000 b.h.p. the experience required will be the same as stated for types specified in paragraph 6.3 of Notice No. 10, except that, in addition, the applicant must have had practical overhaul experience of types of approximately comparable horse-power.

5.2 Practical arithmetical calculations, involving vulgar and decimal fractions, percentages and mensuration.

5.3 The principles of operation of piston engines, with special reference to current types of aircraft engines.

5.4 The preparation of an inspection report on the condition of an engine stripped down for complete overhaul.

5.5 The method of systematically carrying out the complete overhaul.

5.6 The procedure for completing the inspection record on work done for the purpose of overhaul of the component parts.

5.7 The methods of inspection during overhaul of the component parts of an engine for wear, mal-alignment, distortion and damage. The defects likely to be encountered and their rectification, the permissible allowances for wear and distortion and the balancing of parts.

5.8 The inspection during rectification of parts and components and the re-assembly of the engine, of the workshop processes involved, so far as they affect the incorporation and fitment of previously approved replacement parts, including the appropriate protective treatments applicable.

5.9 The methods of inspecting and checking the correct functioning of the ignition, carburation or injection, bonding and, where applicable, coolant systems.

5.10 The inspection of the complete engine including controls for correct assembly and functioning.

5.11 The principles, functioning, operation, adjustment and control of the apparatus used in testing engines.

5.12 The inspection, adjustment and testing of an engine and all its accessories after overhaul, including the measurement of the power developed and of the fuel and oil consumption.

5.13 The preparation of a sketch from which a finished drawing can be made.

5.14 The methods of inspecting and checking the correct functioning of propeller control systems, where applicable.

5.15 The principles of supercharging and the operation and testing of superchargers and boost control systems, where applicable.

5.16 The materials, both ferrous and non-ferrous, used in engine construction.

5.17 The methods of examination and physical testing of both ferrous and non-ferrous metallic materials used in the construction of the engine to ensure compliance with specification requirements.

5.18 The methods of examination and physical testing of metal forgings, castings and pressings used in the construction of the engine, for the detection of characteristic defects which may render them unsuitable and to ensure compliance with both specification and drawing requirements.

5.19 The inspection during fabrication of metallic materials, metal forgings, castings and pressings into engine parts and components, the repair of component parts and of the workshop processes involved, heat treatment, including temperature control, of hardening, tempering, case hardening and normalising procedure, and of welding, white-metalling, soldering, brazing, electro-plating and other protective treatments against corrosion and deterioration.

5.20 The inspection and methods of checking the finished parts and components prior to and during assembly into the complete engine for correct alignment, weight and balance.

6.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in paragraphs 5.1 to 5.20 above, as applicable, and in all cases shall demonstrate in this examination:—

6.1 Their practical knowledge of inspection, the use of measuring instruments and the interpretation of drawings.

6.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations, so far as they affect an aircraft engineer "M" licensed in Category "D".

CHAPTER L 1—9

GRANT AND EXTENSION—CATEGORIES "A" & "C" (HELICOPTERS—INCLUDING ENGINES)

1.—Applicants for the grant of a licence for the certification of helicopters, of a maximum authorised all-up weight of 6,000 lb. or less, before flight shall have had a minimum of one year of general practical experience in the maintenance of helicopters (including engines). In addition, applicants shall have had recent practical experience of the maintenance and inspection of the type of helicopter (including engine) for which application is made.

2.—Applicants accepted for a licence in Categories "A" and "C" (Helicopters—including Engines) will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraphs 3.1 to 3.19 below, according to the construction of the type(s) for which accepted.

3.—SYLLABUS

3.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Categories "A" and "C".

3.2 Practical arithmetical calculations, involving vulgar and decimal fractions, percentages and mensuration.

3.3 The maintenance of a helicopter, including engine(s), and its equipment.

3.4 The various terms used in helicopter construction and aerodynamics and the functioning of each component part of a helicopter.

3.5 The assembly of helicopter structures, with particular reference to the assembly and functioning of the rotors, including transmission.

3.6 The adjustment of the rotors for the purpose of rectifying faults experienced in flight as a result of a defect or mal-adjustment.

3.7 The inspection of electrical installations in helicopters and testing for correct functioning and condition.

3.8 Defects and deterioration in covered surfaces, in timber and metal structures, as applicable, and methods of rectification.

3.9 The principles and functioning of shock-absorbing devices and retracting devices of landing gear, where applicable.

3.10 The methods of effecting minor repairs and replacements.

3.11 The method of checking flying and engine instruments for correct functioning, methods of making check-calibrations, and inspection of instruments and installations in helicopters.

3.12 The preparation of a brief report, illustrated by sketches if necessary, describing the replacements or repairs required in the case of damage.

3.13 The principles of operation of internal combustion engines and the general construction of current types of aircraft engines.

3.14 Methods of inspecting engines during replacement of approved parts, the defects likely to be encountered and their rectification, and the permissible allowance for wear and distortion.

3.15 The inspection, adjustment and testing of an engine and its accessories after the replacement of approved parts, to ensure correct functioning and power output.

3.16 The inspection, before flight, of an engine and its installations, engine ignition apparatus, carburettors, pumps, filters and starting mechanism.

3.17 The use of equipment required to test engines after the replacement of approved parts.

3.18 The principles of supercharging and the operation of superchargers, where applicable.

3.19 The principle of operation of the transmission and the inspection and rectification of faults in the system.

4.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in paragraph 3 above, and in all cases shall demonstrate in this examination:—

4.1 Their practical knowledge of inspection and of the use of measuring instruments and the interpretation of drawings.

4.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations, so far as they affect an aircraft engineer "M" licensed in Categories "A" and "C".

CHAPTER L 1—10

GRANT AND EXTENSION—CATEGORY "X" (COMPASSES)

1.—Applicants for the grant of a licence in Category "X", in respect of the installation and compensation of direct-reading magnetic compasses in aircraft, will be required to produce satisfactory evidence that they have had a minimum of one year of recent general practical experience in the installation and compensation of direct-reading magnetic compasses in aircraft.

2.—Applicants for the grant of a licence in Category "X" in respect of the installation and compensation of remote-reading compasses in aircraft shall, in addition to the experience detailed in paragraph 1, have had at least six months recent general practical experience in the installation and compensation in aircraft of the type of remote-reading compass for which the application is made.

3.—Applicants for an extension to an existing licence in Category "X" (Compasses) to include one further type of remote-reading compass in addition to the type(s) already held, shall have had at least three months' additional experience on the type for which the extension is required.

4.—All applicants accepted for examination for a licence in Category "X" (Compasses) will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraphs 5.1 to 5.8. The applicants referred to in paragraphs 2 and 3 will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the additional subjects detailed in paragraphs 5.9 to 5.11, according to the form of construction applicable to the type of remote-reading compass for which the application is accepted.

5.—SYLLABUS

5.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Category "X".

5.2 The general principles of magnetism; magnetic materials and permanent magnets; polarity and strength of bar magnets; the earth as a magnet; the magnetic meridian and its relationship to the geographic meridian.

5.3 The general principles of construction of typical aircraft compasses, including magnet systems, damping liquid, verge ring and markings, lubber line, grid wires, shock-absorbing suspension and corrector box; the inspection necessary for the detection of common defects that may arise in use.

5.4 The installation of compasses in aircraft; points to be observed, and the procedure adopted, before adjustments are made.

5.5 The precautions to be observed in the choice of a site for, and the preparation of, a "swinging base"; checking the base by means of a landing compass.

5.6 The compensation of compasses in aircraft, including the observation of deviations, the calculations and adjustments necessary for corrections for co-efficients A, B and C, the procedure to be followed after the corrections are made, and the preparation of deviation cards and graphs.

5.7 The use of a landing compass for the checking of compasses in aircraft.

5.8 The compensation of the compass in a marine aircraft afloat by means of a bearing plate, on the aircraft, or by the use of a landing compass ashore.

5.9 The general principles of construction of remote-reading aircraft compasses, the principles of operation and functioning of the particular type for which the application is made and the inspection of the component parts necessary, prior to installation in the aircraft.

5.10 The installation and the correct positioning of the remote-reading compass in the aircraft, including the components and accessories; points to be observed and the procedure adopted before adujstments are made.

5.11 The methods and procedure adopted for the compensation of the remote-reading compass in the aircraft, the adjustments to be made to the master compass, the master indicator, and the repeater units in order to ensure correct functioning.

6.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in paragraphs 5.1 to 5.11, as applicable, and in all cases shall demonstrate in this examination:—

6.1 Their knowledge, in a practical form, of the subjects detailed in paragraph 5.

6.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations so far as they affect an aircraft engineer "M" licensed in Category "X" (Compasses).

CHAPTER L 1—11

GRANT AND EXTENSION—CATEGORY "X" (ENGINE IGNITION APPARATUS)

1.—Applicants for the grant of a licence in Category "X" in respect of the overhaul, repair or modification of aircraft engine ignition apparatus shall have had at least three years' electrical engineering experience, including a minimum of one and a half years of recent general practical experience in the overhaul, repair, and testing of all types of aircraft engine ignition apparatus.

2.—Applicants accepted for a licence in Category "X" (Engine Ignition Apparatus) will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraph 3 below.

3.—SYLLABUS.

3.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Category "X".

5.9 The general principles of construction of remote-reading aircraft compasses, the principles of operation and functioning of the particular type for which the application is made and the inspection of the component parts necessary, prior to installation in the aircraft.

5.10 The installation and the correct positioning of the remote-reading compass in the aircraft, including the components and accessories; points to be observed and the procedure adopted before adujstments are made.

5.11 The methods and procedure adopted for the compensation of the remote-reading compass in the aircraft, the adjustments to be made to the master compass, the master indicator, and the repeater units in order to ensure correct functioning.

6.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in paragraphs 5.1 to 5.11, as applicable, and in all cases shall demonstrate in this examination:—

6.1 Their knowledge, in a practical form, of the subjects detailed in paragraph 5.

6.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations so far as they affect an aircraft engineer "M" licensed in Category "X" (Compasses).

CHAPTER L 1—11

GRANT AND EXTENSION—CATEGORY "X" (ENGINE IGNITION APPARATUS)

1.—Applicants for the grant of a licence in Category "X" in respect of the overhaul, repair or modification of aircraft engine ignition apparatus shall have had at least three years' electrical engineering experience, including a minimum of one and a half years of recent general practical experience in the overhaul, repair, and testing of all types of aircraft engine ignition apparatus.

2.—Applicants accepted for a licence in Category "X" (Engine Ignition Apparatus) will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraph 3 below.

3.—SYLLABUS.

3.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Category "X".

3.2 Elementary electricity and magnetism, definition of the terms used and their application and the elementary practical mathematical calculations involved.

3.3 The construction and functioning of all types of engine ignition apparatus, including screened types fitted to aircraft engines.

3.4 The method of carrying out overhauls and repairs; the inspection necessary to detect defects, mechanical, electrical and magnetic, as a result of wear and deterioration, and the permissible allowances in each case.

3.5 The inspection and testing of component parts and assemblies, and the equipment required for such tests.

3.6 The schedule of tests, the equipment required for such tests, and the methods employed in carrying out functional tests to prove the satisfactory condition of apparatus after overhaul and repair.

3.7 The construction and functioning of impulse starters; the methods of carrying out overhauls, repairs and tests.

3.8 The construction and functioning of automatic timing devices; the methods of carrying out overhauls, repairs and tests.

3.9 The construction, inspection and testing of ignition cables, screened harness and fittings, the defects and deterioration likely to be encountered, and the effect on engine ignition apparatus and sparking plugs, of metal braiding on cables.

3.10 The overhaul and testing of sparking plugs.

3.11 The preparation of a wiring diagram, from which a finished drawing could be made of the internal and external connections of a typical ignition system.

4.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in paragraphs 3.1 to 3.11 above, as applicable, and in all cases shall demonstrate in this examination:—

4.1 Their practical knowledge of inspection, the use of measuring instruments and the interpretation of drawings.

4.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations so far as they affect an aircraft engineer "M" licensed in Category "X" (Engine Ignition Apparatus).

CHAPTER L 1—12

GRANT AND EXTENSION—CATEGORY "X" (V.P. PROPELLERS)

1.—Applicants for the grant of a licence in Category "X" in respect of the overhaul, repair or modification of variable-pitch propellers, shall have had a minimum of one and a half years of recent general practical experience of the overhaul, repair and balancing of variable-pitch propellers, of which at least six months must have been spent on the overhaul and/or repair of the type of propeller for which application is made.

2.—Applicants accepted for a licence in Category "X" (V.P. Propellers) will be required to answer, in written examination, questions in respect of the subjects detailed in paragraphs 3.1 to 3.14 below, according to the form of construction applicable to the type of propeller for which application is accepted.

3.—SYLLABUS.

3.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Category "X".

3.2 Practical arithmetical calculations, involving vulgar and decimal fractions, percentages and mensuration.

3.3 The principles and functioning of the operating systems of current types of variable-pitch propellers.

3.4 The preparation of an inspection report on the condition of the propeller stripped down for complete overhaul.

3.5 The method of systematically carrying out the required overhaul.

3.6 The procedure for completing the inspection record on work done for the purpose of overhaul of the component parts.

3.7 The approved repair schemes applicable to the rectification and overhaul of the component parts.

3.8 The method of inspection during the overhaul of the component parts of a propeller for wear, mal-alignment, distortion and damage. The defects likely to be encountered and their rectification, the permissible clearances and allowances for wear and distortion, and the balancing of parts.

3.9 The inspection during rectification of parts and components and the re-assembly of the propeller, and of the workshop processes involved, so far as they affect the incorporation and fitment of previously approved replacement parts, including the appropriate protective treatments applicable.

3.10 The inspection during rectification of spinners, fans and all parts normally attached to, and rotating with, propellers.

3.11 The construction and functioning of auxiliary oil pumps, motors, constant speed governors, controlling means and de-icing equipment and the methods of carrying out overhauls, repairs and tests.

3.12 The inspection of a complete propeller for correct assembly, adjustment, weight and balance; methods employed for correcting balance and checking torque loading of blades.

3.13 Assembly of a propeller to an engine; check testing and adjustment for performance and correction of faults.

3.14 The preparation of a sketch from which a finished drawing could be made of a part of the operating mechanism of a variable-pitch propeller.

4.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in paragraphs 3.1 to 3.14 above, as applicable, and in all cases shall demonstrate in this examination:—

4.1 Their practical knowledge of inspection, the use of measuring instruments and the interpretation of drawings.

4.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations, so far as they affect an aircraft engineer "M" licensed in Category "X" (V.P. Propellers).

CHAPTER L 1—13

GRANT AND EXTENSION—CATEGORY "X" (INSTRUMENTS)

1.—Applicants for the grant of a licence in Category "X" in respect of the overhaul, repair or modification of aircraft and engine instruments, *excluding* electrically operated instruments, shall have had at least three years' instrument engineering experience, including a minimum of one and a half years of recent general practical experience in the overhaul, repair, calibration and installation in aircraft of all types of physically and mechanically operated aircraft and engine instruments as may be from time to time prescribed in the Air Navigation Regulations.

2.—Applicants for the grant of a licence in Category "X" in respect of the overhaul, repair or modification of aircraft and engine instruments, *including* electrically operated instruments, shall

have had the experience detailed in paragraph 1 above, and shall, in addition, either be holders of a licence in Category "X" (Electrical Equipment) together with at least six months' recent practical experience in the overhaul, repair or modification of electrically operated aircraft and engine instruments, or have had at least one year of recent general practical experience in the overhaul, repair or modification of electrically operated aircraft and engine instruments.

3.—All applicants accepted for a licence in Category "X" (Instruments) will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraphs 4.1 to 4.9 below; the applicants referred to in paragraph 2 will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the additional subjects detailed in paragraphs 4.10 and 4.11 below.

4.—SYLLABUS.

4.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Category "X".

4.2 Elementary physics, and the elementary practical mathematical calculations involved.

4.3 The general principles of construction, operation, overhaul and repair of all types of physically and mechanically operated aircraft and engine instruments.

4.4 The types of failure which may develop in operation; methods adopted to trace the causes, and measures taken to prevent their recurrence; the effect of variation and adjustment on instrument mechanisms.

4.5 The inspection of component parts of the various instruments during overhaul and repair; the correction of physical and mechanical faults peculiar to such instruments.

4.6 The conventional methods of calibrating, adjusting and testing aircraft and engine instruments; high and low pressure, temperature and vibration tests, and luminosity tests on luminous and flourescent dial markings.

4.7 The principles employed, and methods adopted, in the construction and operation of the substandard test apparatus normally used in instrument repair shops for calibration purposes.

4.8 Methods of testing and checking the accuracy of the substandard test apparatus; the use for this purpose of Reference Standards.

4.9 The preparation of a sketch from which a finished drawing could be made of a part of a typical instrument mechanism.

4.10 Elementary electricity and magnetism; definitions of the terms used and their application and the elementary practical mathematical calculations involved.

4.11 The general principles of construction; operation, overhaul and repair of all electrically operated instruments used in aircraft; methods of adjustment, detection and rectification of faults peculiar to specific instruments and equipment, and the tests necessary to prove correct functioning.

5.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in paragraphs 4.1 to 4.11 above, as applicable, and in all cases shall demonstrate in this examination:—

5.1 Their practical knowledge of inspection, the use of measuring instruments and the interpretation of drawings.

5.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations so far as they affect an aircraft engineer "M" licensed in Category "X" (Instruments).

CHAPTER L 1—14

GRANT AND EXTENSION—CATEGORY "X" (ELECTRICAL EQUIPMENT)

1.—Applicants for the grant of a licence in Category "X" in respect of the overhaul, repair or modification of aircraft electrical equipment, including installations in aircraft with main power supply systems the nominal pressure of which does not exceed 30 volts, shall have had at least three years' electrical engineering experience including a minimum of one-and-a-half years of recent general practical experience in the overhaul, repair and testing of aircraft electrical equipment, including recent experience of the inspection and testing of electrical installations in aircraft.

2.—Applicants accepted for a licence in Category "X" (Electrical Equipment) will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraph 3 below.

3.—SYLLABUS.

3.1 British Civil Airworthiness Requirements, so far as they affect an aircraft engineer "M" licensed in Category "X".

3.2 Elementary electricity and magnetism; definition of the terms used and their application, and the elementary practical mathematical calculations involved.

3.3 The construction and functioning of all types of electromagnetic induction machines used on aircraft.

3.4 The method of carrying out overhauls and repairs to electromagnetic induction machines used on aircraft; the inspection necessary to detect defects, mechanical, electrical and magnetic, as a result of wear and deterioration, and the permissible allowances in each case.

3.5 The inspection of component parts of aircraft electrical generators, motors, automatic control and switch gear.

3.6 The schedule of tests, the equipment required for such tests, and the methods employed in carrying out functional tests to prove the satisfactory condition of electrical generators and motors after overhaul and repair.

3.7 The general principles of construction and functioning of all types of automatic control and switch gear; the method of carrying out overhauls, repairs and tests.

3.8 The installation, functioning and testing of all types of electrical storage batteries.

3.9 The selection and inspection of materials used in the construction, repair and overhaul of aircraft electrical equipment.

3.10 The types, sizes and capacities of cables, fuses and switch gear, used in aircraft electrical installation.

3.11 The specified light-angles of navigation lamps; the installation, inspection, overhaul and testing of navigation, signalling and landing-light equipment.

3.12 Methods of inspecting and testing the whole of the electrical system installed in aircraft, including the bonding and earthing system.

3.13 The preparation of a circuit diagram illustrating the symbols used to denote the various items of equipment.

4.—Where, subsequent to the written examination, an oral examination is required by the Board, applicants may be required to answer further questions in respect of the subjects detailed in

paragraphs 3.1 to 3.13 above, as applicable, and in all cases shall demonstrate in this examination:—

4.1 Their practical knowledge of inspection, the use of measuring instruments and the interpretation of drawings.

4.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations so far as they affect an aircraft engineer "M" licensed in Category "X" (Electrical Equipment).

CHAPTER L 1—15

GRANT AND EXTENSION—CATEGORY "X" (AUTOMATIC PILOTS)

1.—Applicants for the grant of a licence in Category "X" in respect of the overhaul, repair, modification, calibration and installation in aircraft of aircraft automatic pilots shall have had at least three years' instrument engineering experience, including a minimum of one-and-a-half years of general practical experience of the repair, modification, calibration, installation and testing of aircraft automatic pilots, of which at least half must have been recent experience concentrated on the particular type of automatic pilot for which the application is made.

2.—Applicants for extension to include one further type of automatic pilot shall have had at least six months' recent practical experience of the particular type or at least three months' recent practical experience of the particular type and, in addition, a satisfactory instruction course at the manufacturers.

3.—Any one application for a licence in Category "X" (Automatic Pilots) will be accepted for one type only in any class of automatic pilot. All applicants will be required to answer, in written examination, questions to demonstrate their knowledge in respect of the subjects detailed in paragraph 4, and in addition, according to the class of automatic pilot for which the application is accepted, questions to demonstrate their knowledge in respect of the subjects detailed in paragraph 5, 6, or 7.

4.—SYLLABUS.

4.1 British Civil Airworthiness Requirements, so far as they affect the aircraft engineer "M" licensed in Category "X".

4.2 Elementary physics and the elementary practical mathematical calculations involved.

4.3 The fundamental principles employed in the construction and operation and their application to the particular automatic pilot for which the application is accepted.

5.—AUTOMATIC PILOTS EMPLOYING HYDRAULIC OPERATION.

5.1 General principles of construction and operation of the control units, sub-assemblies, hydraulic and air systems.

5.2 The necessary inspections prior to installation in the aircraft of the automatic pilot and its sub-assemblies, including oil pumps, regulators and accessories.

5.3 The inspection during and after installation in the aircraft, including procedure for bleeding the hydraulic system. Tests to be carried out to ensure that the automatic pilot can be disengaged quickly and/or manually over-controlled in emergency in flight and that it is correctly installed.

5.4 The types of failure which may develop in operation, methods adopted to trace the causes. The adjustment and rectification of minor faults and measures taken to prevent their recurrence.

5.5 The inspection of component parts of the control units and sub-assemblies during overhaul, repair or modification and the correction of physical and mechanical faults peculiar to such component parts. The effect of variation and adjustment.

5.6 The methods and procedure for lapping, polishing, testing and inspecting ball races, cups, cones and pivots of the gyro systems, gimbal systems and attachments.

5.7 The conventional method of tuning, balancing, calibrating, adjusting and testing during and after overhaul, repair or modification of the sub-assemblies and the complete automatic pilot in the workshop so far as is permitted by the manufacturer's approved overhaul and repair manual.

5.8 The principles employed and methods adopted in the construction, operation, calibration, and testing of the sub-standard test apparatus normally used in automatic pilot repair workshops. The use for this purpose of Reference Standards.

6.—AUTOMATIC PILOTS EMPLOYING PNEUMATIC OPERATION.

6.1 The general principles of operation and construction of the control unit(s) and sub-assemblies including the monitoring system and air system.

6.2 The necessary inspections prior to installation in the aircraft of the automatic pilot and its sub-assemblies, including the compressor, separator and drier.

6.3 The inspection during and after installation in the aircraft. Tests to be carried out to ensure that the automatic pilot can be disengaged quickly and/or manually over-controlled in emergency in flight and that it is correctly installed.

6.4 The types of failure which may develop in operation, methods adopted to trace the causes. The adjustment and rectification of minor faults and measures taken to prevent their recurrence.

6.5 The inspection of component parts of the control units and sub-assemblies during overhaul, repair or modification and the correction of physical and mechanical faults peculiar to such component parts. The effect of variation and adjustment.

6.6 The methods and procedure for lapping, polishing, testing and inspecting ball races, cups, cones and pivots of the gyro systems, gimbal systems and attachments.

6.7 The conventional method of tuning, balancing, calibrating, adjusting or testing during and after overhaul, repair or modification of the sub-assemblies and the complete automatic pilot in the workshop so far as is permitted by the manufacturer's approved overhaul and repair manual.

6.8 The principles employed and the methods adopted in the construction, operation, calibration and testing of the sub-standard test apparatus normally used in automatic pilot repair workshops. The use for this purpose of Reference Standards.

7.—AUTOMATIC PILOTS EMPLOYING ELECTRICAL OPERATION (INCLUDING THOSE WITH ELECTRONIC AMPLIFIERS).

7.1 Electricity and magnetism, definitions of terms used in their application and the elementary practical mathematical calculations involved.

7.2 General principles of operation and construction of the control unit(s) and sub-assemblies including the electrical, hydraulic and/or air systems and monitoring systems where applicable.

7.3 The necessary inspections prior to installation in the aircraft of the automatic pilot and its sub-assemblies.

7.4 The inspection during and after installation in the aircraft, including the security and correct connections of the electrical cable system. Tests to be carried out to ensure that the automatic pilot can be disengaged quickly and/or manually overcontrolled in emergency in flight and that it is correctly installed.

7.5 The types of electrical and mechanical failure which may develop in operation, methods adopted to trace the causes. The adjustment and rectification of minor faults and measures taken to prevent their recurrence.

7.6 The inspection of component parts of the control units and sub-assemblies during overhaul, repair or modification and the correction of physical, electrical and mechanical faults peculiar to such component parts. The effect of variation and adjustment.

7.7 The methods and procedure for lapping, polishing, testing and inspecting ball races, cups, cones and pivots of the gyro systems, gimbal systems and attachments.

7.8 The conventional method of tuning, balancing, calibrating, adjusting and testing during and after overhaul, repair or modification of the sub-assemblies and the complete automatic pilot in the workshop so far as is permitted by the manufacturer's approved overhaul and repair manual.

7.9 The principles employed and methods adopted in the construction, operation, calibration and testing of the sub-standard test apparatus normally used in automatic pilot repair workshops. The use for this purpose of Reference Standards.

8.—GENERAL. Where, subsequent to the written examination, an oral examination is required by the Board, applicants will be required to answer further questions in respect of the subjects detailed in paragraph 4 and, according to the class of automatic pilot for which application is accepted, questions in respect of the subjects detailed in paragraph 5, 6, or 7, and in all cases shall demonstrate in this examination:—

8.1 Their practical knowledge of inspection, the use of measuring instruments and the interpretation of drawings.

8.2 Their knowledge of the Air Navigation (Consolidation) Order and the Air Navigation Regulations, so far as they affect the aircraft engineer "M" licensed in Category "X" (Automatic Pilots).

VII

Preparing for the Examination

From a previous Chapter an idea of the form of the examination should have been gathered. It is obvious that, unlike an oral examination, no clues to the answers can be expected during the course of the examination itself.

To deal effectively with this written examination, made up to cover a syllabus with perhaps only one question to each sub-section, it is most important to cover the whole syllabus beforehand.

The following method is simple to apply and, if carried out honestly, provides a guide to those portions of the syllabus, or specific points requiring special attention, to bring knowledge of them up to standard. If it is found that there are large deficiencies of knowledge to be made up, it would be as well to remedy this state of affairs before applying for a licence.

The method recommended is to expand and itemise the bare examination syllabus as given in Chapter VI, with the object of carrying out a self-conducted quiz to discover weak points which must be cleared up. Tick off all items of which knowledge is satisfactory and make notes against unsatisfactory items to indicate the facts, figures or even practical experience, which are required to complete the knowledge of the subject.

To illustrate the procedure, first the "A" licence syllabus, and then the "C" syllabus, will be considered in this way. The scheme should be sufficiently clear from these examples to enable candidates in Categories "B", "D" and "X" to apply it to the syllabus with which they are concerned.

SYLLABUS FOR AIRCRAFT MAINTENANCE ENGINEER'S LICENCE

CATEGORY "A" EXAMINATION

The items of the syllabus are in CAPITALS

In the written examination applicants will be required to answer questions to show their knowledge of the following, according to the construction of the type(s) for which accepted:—

1. BRITISH CIVIL AIRWORTHINESS REQUIREMENTS, SO FAR AS THEY AFFECT AN AIRCRAFT ENGINEER "M" LICENSED IN CATEGORY "A".

British Civil Airworthiness Requirements are at present available for two guineas, including all amendments and re-issues. However, after a Preliminary Application has been accepted for any category of Aircraft Maintenance Engineer's Licence, the applicant may purchase the British Civil Airworthiness Requirements for one guinea, which is the price charged to aircraft engineers who hold licences.

Civil Aircraft Inspection Procedures, dealing with airframe matters, referred to at the beginning of Chapter VI, should be considered as a guide to the extent of knowledge required

2. PRACTICAL ARITHMETICAL CALCULATIONS, INVOLVING VULGAR AND DECIMAL FRACTIONS, PERCENTAGES AND MENSURATION.

(i) PRACTICAL ARITHMETICAL CALCULATIONS.

The "A" licensed engineer has to make checks on incidence, stagger and dihedral. He should also be able to calculate the volume of a tank, the extent of bow in a member, or make a specific gravity check; he should understand how these measurements are expressed and sub-divided. The calculations referred to necessitate an acquaintance with simple mathematical formulae, the relationship between the diameter, circumference and area of a circle, the volume of regularly-shaped bodies, or weight of a fluid when the specific gravity is known.

(ii) VULGAR AND DECIMAL FRACTIONS.

In order to perform the calculations required of an "A" licensed engineer, an acquaintance with fractions is necessary. A few examples should be solved, involving the use both of vulgar and of decimal

fractions. A good text-book on elementary arithmetic will be helpful when considering the rules for addition, subtraction, multiplication and division. Frequent practice is the only method of attaining any degree of proficiency even with this seemingly simple aspect of the category.

(iii) PERCENTAGES.

Again the arithmetical text-book will help and examples should be attempted until simple percentages such as $12\frac{1}{2}\%$, $8\frac{1}{3}\%$ or $16\frac{2}{3}\%$ can be calculated mentally. As with many other things perfection comes by practice.

(iv) MENSURATION.

A thorough knowledge is necessary of British linear, square and cubic measures, angular and temperature measurement. The relation between British and Metric measures must be known and the conversion of British into Metric units and vice versa.

3. THE VARIOUS TERMS USED IN AEROPLANE CONSTRUCTION AND AERODYNAMICS AND THE FUNCTIONING OF EACH COMPONENT PART OF AN AEROPLANE.

(i) THE VARIOUS TERMS USED IN AEROPLANE CONSTRUCTION AND AERODYNAMICS.

This requires a knowledge of such terms as incidence, dihedral, symmetry, sweepback, angle of attack, chord, span, yaw.

(ii) THE FUNCTIONING OF EACH COMPONENT PART OF AN AEROPLANE.

This means the exact purpose of each individual component part and its function. Practice should be obtained in writing short, concise descriptions of the action of frise and differential ailerons, trim and servo tabs. Obtain a thorough understanding of the function of such parts and of the need for correct setting.

4. THE PREPARATON OF A BRIEF REPORT, ILLUSTRATED BY SKETCHES IF NECESSARY, DESCRIBING THE REPLACEMENTS REQUIRED IN THE EVENT OF DAMAGE, DEFECT OR WEAR.

Practice is most useful in the compilation of reports dealing with typical defects and sustained damage after a forced landing, together with the rectification work and replacements necessary to render the aircraft fit to " fly-off ". Practice should be obtained in drawing line sketches of typical repairs, such as holes in skin with surrounding ribs, formers, etc., layout of hydraulic, vacuum and pneumatic systems.

5. THE INSPECTION AND CHECKS FOR ALIGNMENT AFTER ASSEMBLY OF AEROPANE STRUCTURAL COMPONENTS.

The important points to remember when describing details of inspections and checks is to set them down in the order in which they are carried out. The practice of giving first one point and then another, without regard to order, may lead the examiner to suspect that the applicant would make the inspection in a confused manner. Detail also what equipment is used, e.g. : Is a piece of string suitable for a symmetry check from wing tip to tailplane?

6. THE INSPECTION DURING AND AFTER ADJUSTMENT OF FLYING CONTROLS.

The same remarks apply as to the preceding item. Be sure that control surface movements are known, together with methods of locking turnbuckles, checks for safety, and so on. After adjustments or repairs to flying-control systems, a duplicate inspection is essential; this is a point which is frequently omitted.

7. THE CORRECTION OF FAULTS EXPERIENCED IN FLIGHT WITH PARTICULAR REFERENCE TO RIGGING AND CONTROL SETTINGS.

This is an item of the syllabus which is wide in scope and a list should be made showing typical faults; for example, left or right wing low; tail or nose heavy; yawing in flight; swinging on take-off or landing; controls tight or slack, heavy or light. After the typical faults have been considered, the possible causes should be set against each; these may be any one or more of the following: —

(*a*) maladjustment of control surfaces
(*b*) maladjustment of aircraft structure
(*c*) defect in a control surface
(*d*) defect in the aircraft structure
(*e*) incorrect or uneven distribution of load
(*f*) engine or propeller faults, according to type.

If the defects and possible causes are set out in tabular form, a third column should then be added with the rectifications, inspections and certifications necessary, not forgetting duplicate inspection after any adjustment to the flying controls.

8. GENERAL MAINTENANCE (INCLUDING EQUIPMENT) AND MINOR REPAIRS.

(i) GENERAL MAINTENANCE AND MINOR REPAIRS.

This can be expanded for consideration on these lines: knowledge is required of the periodical maintenance and inspection checks carried out on the aircraft generally; the extent of the various in-

spections which are called for by the maintenance schedules; the cleaning and greasing necessary at regular intervals; the method of carrying out final inspections for safety for flight, and the certification of these. The relevant manufacturers' handbooks will give details of the minor repairs permitted. Consider, for example, a repair to the trailing edge of a rudder.

(ii) EQUIPMENT.

What comes under this heading? It is convenient to consider here the items not specifically mentioned elsewhere in the syllabus, such as, for example:—

Lifebelts, safety belts, lap straps, etc.

Answer these questions about each item:—

What periodical maintenance and inspection is performed? At what intervals? What testing apparatus is used? What are the requirements regarding them?

9. DEFECTS AND DETERIORATION OF METALLIC MATERIALS, TREATMENTS AND METHODS USED AGAINST CORROSION.

A list may be made of the defects and deterioration which may occur in ferrous and non-ferrous metal aircraft structures, for example:—(1) corrosion, (2) bent fittings, bowed struts or members, (3) cracked fittings, (4) worn or elongated holes, bushes, etc., (5) worn bolts or pins. The list may then be expanded to show the limits of defect or deterioration which would permit the affected part to be put back into service, methods of measuring the extent of wear or deterioration and the methods of rectification which come within the scope of an "A" licensed engineer's duties as defined in Chapter III. Practical knowledge should be obtained of the method of measuring a small hole for ovality.

When considering this item, as many examples as possible should be given, affecting both minor and major components. In addition, it should be remembered that the defects may be the result of abnormal conditions, such as a heavy landing, which will call for an extensive inspection for the effect of transmitted stresses and strains.

The different processes for preventing corrosion should be studied, together with their application and suitability.

10. Defects and Deterioration of Wooden Structures, Including Treatments and Methods Used in Connection with them, where Applicable.

This may be approached in the same manner as item 9 and a list made of the various defects and deterioration which may be found: (1) shrinkage, (2) separated laminations of ply, (3) oil and water soakage, (4) compression shakes, etc. The engineer must be able to recognise a compression shake when he sees one through a small aperture in a wing covering, peering with a torch and perhaps the aid of a mirror. Drawings of these shakes in books are easy to remember, but the shakes are not so easily recognised when seen in timber for the first time. Shakes are, of course, dangerous and every effort should be made to become acquainted with them by practical means.

When the list of typical defects has been completed, the appropriate treatments and methods may be set down against each, bearing in mind the scope of the "A" licensed engineer's duties as defined in Chapter III.

11. Defects and Deterioration of Materials—Other than Wood or Metal—Including Fabric, Dopes, etc. Treatments and Methods Used in Rectifying Defects Encountered, where Applicable.

This covers fabric, doping, stringing, transparent window material, glues and cements, etc. As before, a list should be compiled giving the typical defects which may develop in all these, together with the necessary rectifications. In the case of fabric, practice should be obtained in writing descriptions of the repair of jagged holes, broken stringing, re-doping. It should not be forgotten that wrinkles in fabric or buckling of ply or metal skin usually indicate serious damage. The rectification work, or indeed the inspection, does not end by simply having the covering replaced.

12. The Inspection of Control Mechanisms for Defects and Deterioration.

Again the best way to deal with this is to list the various defects which may be found—frayed cables, cables fouling, oil-soaked fairleads, cables too tight or too slack, pulled splices, and so on—and against them detail the rectification necessary. The effect of climatic conditions on the tension of control systems should also be considered. Attention is again directed to the necessity for duplicate inspection after adjustments or repairs to the control system.

13. Inspection and Scope of Investigation Following Heavy Landings.

This is a wide subject, since the inspection following a heavy landing cannot be too thorough. As much detail as possible should be compiled, having regard to a definite order of investigation, from important to less important components. It should be noted that this investigation should include such things as spars, engine bearers, tank attachments, instruments, seats, accumulators, as well as the obvious things such as the undercarriage. Such inspection should be continued until some defect provides evidence that the shock sustained has been relieved. It is surprising at times how far from the undercarriage the results of a heavy landing can be found, and experience has shown that it is exceptional if no defects are found.

14. The Methods of Checking Flying Instruments for Correct Functioning, the Inspection of Instruments and Instrument Installations in Aeroplanes, and Methods of Making Check Calibrations.

After a list has been made of instruments, such as altimeters, airspeed indicators, turn indicators, etc., a short description should be given. The method of operation of each should be stated and the main points added which require attention to ensure satisfactory operation during installation. For instance, what effect would a blocked filter have on an air-driven turn indicator ?

An ex-Service applicant for an "A" licence should bear in mind that the civil procedure differs from the Service procedure in that the "A" licensed engineer is responsible for checking the flying instruments when installed, and should, therefore, know the method of checking for accuracy, with approximate limits of error allowed, possible defects and symptoms. This leads to notes on portable calibrators and methods of using them.

15. The Inspection of Electrical Installations in Aeroplanes and Testing for Correct Functioning and Condition.

This portion of the syllabus is recommended as the subject for very strict self-examination. Quite commonly much of such work is carried out on aircraft by specialist electricians, as part of their duties. A definite effort may be necessary to secure the practical experience and knowledge of this subject, especially in the case of the ex-Service applicant (see previous item).

The duties of an "A" licensed engineer in this respect cover inspection of such works as: —

(i) The inspection and testing for correct functioning and condition of any electrical services which may be necessary when assembling an aircraft or changing a component, or the repair and rectification of minor faults. This involves knowledge of tests for continuity and insulation and correct functioning, including the methods and apparatus used, and results desired. (See Chapter III.)

(ii) The bonding system on an aircraft, and the methods of testing it, with apparatus used, and results desired.

(iii) The care and maintenance of the aircraft batteries. The candidate should be familiar with the methods and means of carrying out checks for specific gravity of the electrolyte, voltage, capacity and general condition, and results desired.

In all the above, it is necessary to be familiar with the minimum standard acceptable, and results usually obtained.

Make a list of all the points mentioned above, and make certain that they are covered by adequate knowledge and practical experience.

16. The Inspection of Undercarriage Shock-Absorbing Legs, Brakes, Wheels and Tyres.

(i) the inspection of undercarriage shock-absorbing legs.

First, make a careful study of the types fitted to the aircraft for which examination is being undertaken, such as: air; air/oil; rubber; steel spring; " liquid spring ", etc.

With each type make notes as to the principle and functioning of it, together with maintenance and checking required, possible defects, points where wear may occur, and replacements which may be made.

(ii) brakes, wheels and tyres.

Make a study of distinct makes of each of the types of brakes systems, both pneumatic and hydraulic, and practice sketching the layouts of each system, with components, pressures, valves, etc.

List the typical defects commonly to be found in tyres—cuts, bulging, creep, etc.—and note also the correct air pressures to be maintained and repairs permitted. Become familiar with the limits of defects before rejection of the tyre becomes necessary.

17. THE PRINCIPLES OF OPERATION OF RETRACTING UNDERCARRIAGE AND FLAP OPERATING SYSTEMS AND INSPECTION OF THESE SYSTEMS INSTALLED IN AEROPLANES, WHERE APPLICABLE.

For convenience, the whole system may be considered in conjunction with the landing gear retracting and flap operating mechanism. Make notes on the general principles involved; become familiar with the types of system employed in the aircraft being considered and the component parts found in such systems generally. Then list methods of testing and checking the systems after assembly to the main aircraft structure, defects commonly encountered, their symptoms, and methods of rectification.

Ability to draw a diagram of a typical system is a useful check on the knowledge required to appreciate fully both principles and practice in this subject.

Finally, give some thought to the various emergency systems which are provided, in the case of failure of the normal system of lowering the landing gear. These may rely upon compressed air, CO_2, reserve fluid, and hand pump, cordite cartridges, bunjee cords, or gravity. How are these emergency systems tested, maintained and inspected ?

18. WHERE APPLICABLE, GENERAL PRINCIPLES OF OPERATION OF THE PARTICULAR TYPE OF AUTOMATIC PILOT INSTALLED IN THE AEROPLANE(S).

This is self-explanatory and the relevant manufacturers' handbooks should be studied.

19. WHERE APPLICABLE, METHODS OF COUPLING THE AUTOMATIC PILOT SYSTEM TO THE AIRCRAFT FLYING CONTROLS. TESTS TO ENSURE THAT THE AUTOMATIC PILOT CAN BE IMMEDIATELY DISENGAGED AND/OR OVER-CONTROLLED IN ANY EMERGENCY.

This, like the preceding item, is self-explanatory and calls for study of the appropriate procedures.

20. WHERE APPLICABLE, THE DAILY MAINTENANCE AND PERIODICAL INSPECTIONS NECESSARY TO ENSURE CORRECT OPERATION AND FUNCTIONING OF AUTOMATIC PILOT INSTALLATIONS. SUCH MINOR REPLACEMENTS AND ADJUSTMENTS ON THE AEROPLANE AS SPECIFIED IN THE MAINTENANCE MANUAL AS BEING WITHIN THE SCOPE OF AN AIRCRAFT ENGINEER "M" LICENSED IN CATEGORY "A".

Although the aircraft engineer licensed in the appropriate rating of Category " X " is responsible for the Automatic Pilot Installations, the aircraft engineer licensed in Category "A" is responsible for the daily maintenance and periodical inspection as well as for functioning checks as specified in the respective makers' instructions. Study of the relevant makers' handbooks is therefore called for.

Where, subsequent to the written examination, an oral examination is required by the A.R.B., applicants may be required to answer further questions in respect of the subjects detailed in the foregoing items and in all cases shall demonstrate in this examination : —

21. THEIR PRACTICAL KNOWLEDGE OF INSPECTION AND THE USE OF MEASURING INSTRUMENTS AND THE INTERPRETATION OF DRAWINGS.

(i) PRACTICAL KNOWLEDGE OF INSPECTION.

This is very wide in scope and is especially directed towards ascertaining the applicant's practical knowledge, as opposed to his textbook knowledge. For example, in the written examination an applicant may have described a particular repair or process in rather a theoretical manner, or he may have omitted some important detail; in the oral examination, he may be asked to amplify his written answer. The obvious conclusion, therefore, is to obtain practice by describing orally as many processes, repairs, adjustments, checks, etc., as possible.

(ii) THE USE OF MEASURING INSTRUMENTS AND THE INTERPRETATION OF DRAWINGS.

This covers the practical use of the micrometer, vernier and other gauges and familiarity with their use is essential.

Practice in the interpretation of drawings is easily obtained in the study of the different manuals and handbooks, at the same time following the printed explanations.

22. THEIR KNOWLEDGE OF THE AIR NAVIGATION (CONSOLIDATION) ORDER AND THE AIR NAVIGATION REGULATIONS, SO FAR AS THEY AFFECT AN AIRCRAFT ENGINEER " M " LICENSED IN CATEGORY "A".

A licensed maintenance engineer should have access to all the Orders and Regulations applicable to his duties, even if he does not possess a personal copy. For the purposes of the examination, A.R.B. Handbook No. 1 will be found convenient for study. It is

not statutory, however, and should not be quoted as an authority. For this purpose, marginal references are given for all quotations from the Regulations and Orders.

It should be appreciated that all that has been written dealing with the syllabus in Category "A" has been in the nature of an illustration of a method of tackling it. It should not be assumed that the examples given are complete and sufficient, as these will vary directly with a candidate's knowledge of any section.

SYLLABUS FOR AIRCRAFT MAINTENANCE ENGINEER'S LICENCE

CATEGORY "C" EXAMINATION

The items of the sylabus are in CAPITALS

In the written examination, applicants will be required to answer questions to show their knowledge of the following according to the type(s) of engine(s) for which accepted:—

1. BRITISH CIVIL AIRWORTHINESS REQUIREMENTS, SO FAR AS THEY AFFECT AN AIRCRAFT ENGINEER "M" LICENSED IN CATEGORY "C".

British Civil Airworthiness Requirements are at present available for two guineas, including all amendments and re-issues. However, after a Preliminary Application has been accepted for any category of Aircraft Engineer's "M" Licence, the applicant may purchase British Civil Airworthiness Requirements for one guinea, which is the price charged to aircraft engineers who hold licences.

Civil Aircraft Inspection Procedures, dealing with engine matters, referred to at the beginning of Chapter VI, should be considered as a guide to the extent of knowledge required.

2. PRACTICAL ARITHMETICAL CALCULATIONS INVOLVING VULGAR AND DECIMAL FRACTIONS, PERCENTAGES AND MENSURATION.

(i) PRACTICAL ARITHMETICAL CALCULATIONS.

The "C" licensed engineer will have to make calculations connected with fuel flows and should also be able to calculate compression ratios, the volume of a cylinder, or make a specific gravity check. These calculations necessitate an acquaintance with simple mathematical formulae, the relationship between the diameter, circumference and area of a circle, volume of regularly-shaped bodies or weight of a fluid when the specific gravity is known.

(ii) VULGAR AND DECIMAL FRACTIONS.

In order to perform the calculations required of a "C" licensed engineer, an acquaintance with fractions is necessary. A few examples should be solved, involving the use both of vulgar and of decimal fractions. A good text-book on elementary arithmetic will be helpful when considering the rules for addition, subtraction, multiplication and division. Frequent practice is the only method of attaining any degree of proficiency even with this seemingly simple aspect of the category.

(iii) PERCENTAGES.

Again the arithmetical text-book will help, and examples should be attempted until simple percentages such as $12\frac{1}{2}\%$, $8\frac{1}{3}\%$ or $16\frac{2}{3}\%$ can be calculated mentally. As with many other things perfection comes by practice.

(iv) MENSURATION.

A thorough knowledge is necessary of British linear, square and cubic measures, angular and temperature measurement. The relation between British and Metric measures must be known and the conversion of British into Metric units and vice versa.

3. THE PREPARATION OF A BRIEF REPORT, ILLUSTRATED BY SKETCHES IF NECESSARY, DESCRIBING THE REPLACEMENTS REQUIRED IN THE EVENT OF DAMAGE, DEFECT OR WEAR.

Practice will be necessary in the compilation of reports dealing with typical defects and sustained damage, together with rectification work and replacements considered necessary to permit a flight back to base. Practice should be obtained in drawing line sketches of typical defects, such as position of cracks or dents in engine mounting frames. An intelligent sketch can convey much and may mean the incorporation of a repair in lieu of an awkward replacement.

4. METHODS OF INSPECTION FOR DEFECTS DURING RECTIFICATION, CLEARANCES AND ALLOWANCES FOR WEAR AND DISTORTION.

(i) METHODS OF INSPECTION FOR DEFECTS DURING RECTIFICATION.

Just how should each of the following be inspected. For example: gudgeon pins, connecting rods (without removing them from the engine), small end locations in connecting rod and in piston, valves, valve springs, piston rings ?

Make a comprehensive list of the parts which come within the scope of a "C" licence engineer, then add notes on likely defects, expressed in broad terms which may assist in calling to mind defects associated with particular parts:—

cracks
fractures
wear on inside diameters
ovality on inside diameters
wear on outside diameters
ovality on outside diameters
deterioration of protective treatments and finishes
distortion or loss of properties due to overheating
deterioration in qualities of springs
deterioration of mating faces or seatings

What shaped gauge should be used for measuring ovality of, say, piston bosses ? Find the correct gauge to use, ascertain the reason for its size and the importance of its shape.

Which parts are most likely to need replacements ? Which parts are always scrapped and new parts fitted ? Why ?

(ii) CLEARANCES AND ALLOWANCES FOR WEAR AND DISTORTION.

After consideration of the defects likely to be encountered, note approximate tolerances and limits permissible for wear and distortion. This must not be dodged with the excuse that such matters are best not committed to memory. An engineer should know whether any figure should be about 0.020 in. or 0.001in. The man-in-the-street does not memorise the rail time table, but ask him the times and intervals between his trains to and from business—he knows. *USE* or *EXPERIENCE begets knowledge.*

5. METHODS OF RECTIFICATION OF DEFECTS, INSPECTION DURING AND AFTER RE-ASSEMBLY.

(i) METHODS OF RECTIFICATION OF DEFECTS.

Making use of the list of likely defects compiled under the previous item, set down against each the rectification necessary.

(ii) INSPECTION DURING AND AFTER RE-ASSEMBLY.

Having ascertained the methods of rectifying all defects, it now becomes necessary to ensure correct inspection during and after re-assembly; for example, it is of no use ensuring that a cylinder is correctly secured if the gudgeon pin inside it has not been correctly lubricated and locked. Make a list of the order of erection and state against this list the inspection checks to be carried out.

6. INSPECTION AND CHECKS ON COMPLETE INSTALLATION AND SYSTEMS, AS REQUIRED DURING ENGINE INSTALLATION.

The applicant should visualise an engine being installed in an aircraft; taking an aircooled radial with a single speed supercharger and a V.P. propeller as an example, a list of checks should be made on the following lines: —

Priming
starting
oil pressure
fuel pressure
oil temperature
mag. switches
V.P. propeller
cylinder head temperature
mag. drop
boost settings
maximum R.P.M.
power
slow running mixture
slow running R.P.M.
slow running cut-out

It should be clearly understood that the checks must include those applicable to the various systems, fuel, oil, etc., and that they should be in their correct order. Inspection of the various systems will be covered in Civil Aircraft Inspection Procedures referred to in Chapter VI.

Notes against each item should be made showing the purpose of the check, reasons which may exist for making the checks in a particular order, and the results which may be obtained, good and bad. As before, make certain that the reasons for recommendations are understood: for instance, why is it better to check mag. drop with the propeller on its fine pitch stops ? How can it be ensured that this is so ? Why is a special check for power necessary ? What is the manufacturer's recommendation for this check ? Why are maximum boost and R.P.M. on modern large engines not reliable as indications that the engine is giving its usual power ?

It is not easy to understand just what is happening on an installation equipped with a constant speed propeller and a boost control, without considerable experience of running such engines coupled with an enquiring mind which does not rest until it has an answer for the problems which arise. For example, on four-engined aircraft, a sheared fuel pump drive may cause a failure of one engine which could be overlooked for some time. After failure of the engine, the oil pressure, boost pressure and R.P.M. would remain normal: Why? Three other instruments would indicate something wrong after a time: What would they be and how would they indicate the trouble ?

Having made preliminary notes on these lines, become familiar with results obtained on the engines for which examination is being undertaken, taking into account variations permissible. Consider also possible defects shown up during the run, methods of checking for possible causes, and rectification of them. Ground testing modern engines calls for a different technique which must be employed in relation to the various types of engines. The A.R.B. have, therefore, requested all engine manufacturers to make this information available by issuing " Service Instructions " to explain the precautions which must be observed, and the technique which must be employed, when ground testing their engines.

7. The Methods of Checking Engine Instruments for Correct Functioning, the Inspection of Engine Instruments and Instrument Installations in Aeroplanes, and Methods of Making Check Calibrations.

First, make a list of instruments such as R.P.M. indicator, oil pressure gauge, boost gauge, oil temperature gauge, etc. Notes should be made giving a brief description of the principles of oper-

ation of each, the units and range of the graduations and the advantages and disadvantages of the different types in use.

Using this list as a basis, deal with the checking of each instrument for accuracy when installed, with approximate limits of error allowed, and possible defects and symptoms. This leads to notes on portable calibrators and the methods of using them.

It should be borne in mind by the ex-Service applicant for a "C" licence that civil procedure differs from Service procedure in that the "C" licensed engineer is responsible for the serviceability and checking the engine instruments when installed.

8. Testing and Tuning During Ground Running in Accordance with the Manufacturer's Recommended Procedure, including Diagnosis of all Types of Running Faults.

(i) testing and tuning during ground running in accordance with the manufacturer's recommended procedure.

This obviously calls for detailed study of the relevant portions of the maker's "Service Instructions", in conjunction with actual practical experience. Practice should be obtained in condensing the vital information given. See also item 6.

(ii) diagnosis of all types of running faults.

The best method of dealing with this will be to make a list of all the usual defects—rough running, overheating, flames from exhaust, carburation and ignition faults, etc.—and against these set down the likely symptoms which would give rise to suspicion of such defects.

9. Preparing Engines for Initial Installation and Inhibiting After Removal; Inspection During Daily Maintenance and Periodical Servicing.

(i) preparing engines for initial installation and inhibiting after removal.

This calls for a knowledge of the method of inhibiting an engine for storage purposes, etc., and also with the preparation of an engine for installation after storage and the consequent removal of the inhibitor, etc. Again a guide will be found in the maker's handbook and the applicant should extract the important points and summarise them into a concise description.

(ii) INSPECTION DURING DAILY MAINTENANCE AND PERIODICAL SERVICING.

This can be expanded for study on these lines: knowledge is required of the periodical maintenance and inspection checks carried out on the engine installation; the extent of the various inspections which are called for by the maintenance schedules; the cleaning and greasing necessary at regular intervals, the method of carrying out engine runs and final inspections for safety for flight, and the certification necessary.

Make a list of the external parts of the engine installation to be studied, preferably while viewing an actual installation, or a set of good photographs of it. Then make notes of the inspection checks which are required.

For example, in the case of an air-cooled radial tackle the job systematically, and sub-divide the engine installation in a simple way into three sections, say: front, cylinders and crankcase, and rear of engine.

Then against each sub-division list the main points, like this:—

Front Section	*Cylinder Section*	*Rear Section*
Sump filter	Cylinders	Magnetos
Propeller	Cylinder heads	Carburettor
Exhaust system	Rocker gear	Pipe lines
Pipe lines	Exhaust stubs	Filters
Reduction gear	Induction pipes	Pumps
etc.	Sparking plugs	Compressors
	Ignition harness	Starters
	etc.	Controls
		etc.

Now expand this bare list to include main points for which each item will be inspected, possible defects and how they should be detected and rectified, any testing apparatus which may be used.

There is a reason for the sump filter being specified as the first item to be inspected in the bare sample list above. What is the reason?

Include in this section notes on work and adjustments which may be necessary when installing the engine, including fitting starters, pumps, propellers, magnetos, etc., and checking them for correct assembly and functioning.

After making notes on the inspection procedure, carry on to the engine run-up. With modern engines, especially in multi-engined aircraft, even experienced personnel find it advisable to

have a list of checks prepared beforehand, so that nothing is missed during the run. Most engines cannot be run repeatedly or for long periods on the ground, and the checks must be made systematically to reduce ground-running time to a minimum.

See also item 6.

10. WHERE APPLICABLE, THE ASSEMBLY OF VARIABLE-PITCH PROPELLERS DISMANTLED FOR EASE OF TRANSPORT, ASSEMBLY OF PROPELLER TO ENGINE, INSPECTION OF DAMAGE TO PROPELLERS, PERMISSIBLE LIMITS AND METHODS OF RECTIFICATION.

A "C" licensed engineer is expected to be competent to certify the satisfactory assembly (in addition to the correct attachment to and functioning when fitted to an engine) of a propeller which has been received with blades dismantled, for ease of transport. Consequently, a knowledge of the construction of typical propellers and rectification which a "C" licensed engineer is permitted to certify, is essential.

11. WHERE APPLICABLE, THE PRINCIPLES OF OPERATION OF VARIABLE-PITCH PROPELLERS AND CONTROLLING DEVICES; INSPECTION OF CORRECT ASSEMBLY AND FUNCTIONING; GROUND TESTING AND RECTIFICATION OF DEFECTS.

Notes should be made on the principles of operation of variable-pitch propellers, including constant speed units, followed by further notes on possible defects, adjustments, and rectifications which may be necessary. Feathering and unfeathering systems and checks should also be covered.

12. THE PRINCIPLES OF OPERATION OF PISTON ENGINES AND THE GENERAL CONSTRUCTION OF CURRENT TYPE(S) OF ENGINES FOR WHICH ACCEPTED.

List all the principles and points that come to mind, or arise during the study of manuals and books, and make sure that they are fully understood. The candidates should have a satisfactory knowledge of the following for example:—

four stroke cycle
magnetos—different types
firing orders
advance and retard
poppet sleeve valves
timing diagrams
valve overlap
why sometimes retarded at larger throttle openings?
relation of mag speed of rotation } to crankshaft speed.
relation of cam gear speed of rotation }

13. Constructional Details of Parts the Rectification of which may be Certified by the Holder of a Licence in Category "C".

It is useful to have some idea of the construction, materials, treatments, surface finishes, protections, and methods used in securing various parts of typical engines of various types in current use. It is essential, however, to have a thorough knowledge of these matters in relation to all the parts which come within the "C" licensed engineer's scope for rectification or adjustment. These parts include cylinders, pistons, cylinder heads, valves, springs, valve operating gear, carburettors, injectors, and automatic mixture and throttle controls.

14. Typical Running Faults and Defects Calling for Partial Overhaul or Other Rectification which may be Certified by the Holder of a Licence in Category "C".

This should be studied in conjunction with Item 8 and the list formed under the latter item expanded to show, after diagnosis, the rectification or partial overhaul necessary.

15. The Principles, Arrangement and Inspection of the Complete Fuel, Oil (and Coolant, where applicable) Systems, and Tests for Functioning and Defects and Methods of Rectification.

This is self-explanatory and the candidate should practise sketching the layouts of various systems and below each sketch lists should be made of the different functioning tests and of typical defects with rectifications necessary.

16. Inspection of Ignition Systems for Correct Installation, Condition, Timing and Functioning, and Tests for Defects and Methods of Rectification.

The "C" licensed engineer is responsible for the inspection of ignition systems for condition, functioning, continuity and insulation (see Chapter III).

The overhaul, repair or modification of ignition systems is the responsibility of the aircraft engineer licensed in the appropriate rating of Category "X", but the applicant must make himself familiar with the general principles of ignition systems, their correct installation, condition and functioning. He must also have practical knowledge of the tests for defects, including continuity and insulation tests and of the methods of rectification of defects found.

17. THE PRINCIPLES OF OPERATION OF CARBURETTORS AND/OR INJECTORS; INSPECTION OF CARBURETTORS AND/OR INJECTORS, CONTROLS AND INDUCTION SYSTEMS; TESTS FOR FUNCTIONING AND DEFECTS.

This is another self-explanatory item and the relevant manufacturer's manuals should be studied and sketches made (with explanatory notes) to show the principles of operation. Lists of defects should also be made, with symptoms which would lead to their diagnosis and the rectification necessary.

18. WHERE APPLICABLE, THE INSPECTION OF FIXED-PITCH PROPELLERS AND CHECKS DURING ASSEMBLY TO ENGINE.

This again is self-explanatory and notes should be compiled from the various manufacturer's manuals. Include also notes on the limits of various defects and methods of rectification. What are the factors governing the fitting of a propeller to any particular engine?

19. WHERE APPLICABLE, THE PRINCIPLES OF SUPERCHARGING AND THE OPERATION OF BOOST CONTROLS; INSPECTION FOR CORRECT ASSEMBLY, ADJUSTMENT AND FUNCTIONING.

First, the definitions regarding power, R.P.M. and power at altitude given in British Civil Airworthiness Requirements, should be memorised.

To understand this subject, some study of the characteristics of the atmosphere is necessary, particularly with regard to the effect of changes in altitude and temperature on density and pressure.

The next step is to consider the mechanical means used to supercharge an engine, and the function of the various parts. Consider this in relation to current practice exemplified in different types of engines under review. The effect of the power required to drive the blower, and of the temperature rise across it, should be noticed.

Finally, the comparison of power at sea level, and at altitude for the same R.P.M. and boost should be considered in conjunction with the notes on carburettors and their automatic controls, suggested earlier when dealing with item 17 above.

Where, subsequent to the written examination, an oral examination is required by the A.R.B., applicants may be required to answer further questions in respect of the subjects detailed in the foregoing items Nos 1 to 19, and in all cases shall demonstrate in this examination:—

20. THEIR PRACTICAL KNOWLEDGE OF INSPECTION AND THE USE OF MEASURING INSTRUMENTS AND THE INTERPRETATION OF DRAWINGS.

(i) PRACTICAL KNOWLEDGE OF INSPECTION.

This is very wide in scope and is especially directed towards ascertaining the applicant's practical knowledge, as opposed to his text-book knowledge. For example, in the written examination an applicant may have described a particular procedure in rather a theoretical manner, or he may have omitted some important detail; in the oral examination, he may be asked to amplify his written answer. The obvious conclusion, therefore, is to obtain practice by describing orally as many procedures, rectifications, adjustments, checks, etc., as possible.

(ii) THE USE OF MEASURING INSTRUMENTS AND THE INTERPRETATION OF DRAWINGS.

This covers the practical use of the micrometer, vernier and other gauges and familiarity with their use is essential.

Practice in the interpretation of drawings is easily obtained in the study of the different manuals and handbooks, at the same time following the printed explanations.

21. THEIR KNOWLEDGE OF THE AIR NAVIGATION (CONSOLIDATION) ORDER AND THE AIR NAVIGATION REGULATIONS, SO FAR AS THEY AFFECT AN AIRCRAFT ENGINEER "M" LICENSED IN CATEGORY "C".

A "C" licensed engineer should have access to all the Orders and Regulations applicable to his duties, even if he does not possess a personal copy. For the purposes of the examination, A.R.B. Handbook No. 1 will be found convenient for study. It is not statutory, however, and should not be quoted as an authority. For this purpose, marginal references are given for all quotations from the Regulations and Orders.

It should be appreciated that all that has been written dealing with the syllabus in Category "C" has been in the nature of an illustration of a method of tackling it. It should not be assumed that the examples given are complete and sufficient, as these will vary directly with a candidate's knowledge of any section.

List of Text Books

obtainable on loan from the Society's Library, by members only, upon application to: The General Secretary,

THE SOCIETY OF LICENSED AIRCRAFT ENGINEERS,
FINSBURY CIRCUS HOUSE, BLOMFIELD STREET,
LONDON, E.C.2.

PROPELLERS.

CODE NO.	
A.S.1.	Airscrews. Parts 1 and 2.
A.S.7.	The de Havilland Controllable Pitch and Constant Speed Airscrew.
A.S.10	The de Havilland Hydromatic Propeller (Service Manual).
A.S.11. } A.S.12. }	The de Havilland Propeller (Technical Service Bulletins).
A.S.14.	Emergency Repairs to Wooden Propeller Blades.
A.S.15.	Rotol Nos. 4 and 5 size. Hydraulically operated Propellers.
A.S.16.	„ „ 5 „ 6 „ „ „ „
A.S.17.	„ No. 6 size. Electrically operated propellers.
A.S.18.	Instructions for re-assembly of Hydraulically and Electrically operated Rotol propellers.
A.S.19.	Rotol constant speed propellers.
A.S.20.	Rotol propellers. (Service Bulletins).
A.S.22.	de Havilland Hydromatic (3 bladed) Constant Speed Feathering Braking Propellers.
A.S.25.	Hamilton Standard Propeller Governors.

AIRFRAMES AND RIGGING.

A.F.1.	The rigging and maintenance and inspection of aircraft (A. Licence).
A.F.2.	Inspection of aircraft after overhaul (B. Licence).
A.F.3.	The airframe and Engine Fitters manual.
A.F.4.	Metal Aircraft construction.
A.F.5.	The construction of Wooden Aircraft.
A.F.6.	Airframes.
A.F.7.	The Aeroplane Structure.
A.F.8.	Airframe Construction and Repairs to Metal Stressed Skin.
A.F.10.	Airframes (Pt. 1).
	Airframes (Pt. 2).
A.F.12.	Airframes (Pt. 3).

ELECTRICAL SYSTEMS, INCLUDING IGNITION EQUIPMENT.

E.R.5.	Magneto.
E.R.6.	Starters and Generators.
E.R.8.	Ignition Equipment, as used on the de Havilland Gipsy Six. Engines.
E.R.16.	The A.B.C. of Storage Battery Management.
E.R.4.	Aircraft Radio.
E.R.20.	Simms Compensated Voltage Control Dynamos.
E.R.21.	Simms Electric Starter Motors and Starter Switches.
E.R.26.	Electrons in Action.

(*Continued*)

Code No.	
	Instruments.
I.1.	Instruments (X Licence).
I.3—6.	Kollsman Equipment.
I.16.	Sperry Gyrospyn Compass.
I.17.	Sperry Automatic Pilot Servicing Instructions.
I.18.	Sperry Gyroscopic Flight Instruments.
I.19.	The Gyroscope and its Applications.
I.20.	Scientific Instruments.
I.21.	Smiths Aircraft Instruments.
I.27.	Kelvin Aircraft Instruments.
	Engines.
E.1.	Aero-engines (C. and D Licences).
E.4.	Aero-engines Overhaul testing and Installation for Ground Engineers.
E.9.	Aero engine theory simply explained.
E.10.	Altitude control of superchargers.
E.2.	Notes on Supercharging for Ground Engineers.
E.11.	Aero-engines for Pilots and Ground Staff.
E.13.	Aircraft Engineer's "C" Licence.
E.14-19	Aeroplane Engines (Parts 1-VI).
E.20.	Aero engine Practice.
	Hydraulics and Pneumatics.
H.P.1.	Reference Book of Aircraft Wheels, Brakes and Oleo Structs.
H.P.2.	Landing Legs, Wheels and Brakes.
H.P.3.	Aircraft Hydraulics simplified.
H.P.21.	Dowty Hydraulic Equipment.
	Theory of Flight, etc.
T.F.2.	Flight without formula.
T.F.3.	An introduction to Aeronautical Engineering. Vol. 1 Mechanics of Flight.
T.F.5.	An introduction to Aeronautical Engineering. Vol. III. Properties and strength of materials.
	Aircraft Fitting, etc.
W.P.1.	The aircraft bench fitter.
W.P.2.	Blue print reading—simplified.
W.P.3.	Engineering and aircraft limits, fits and tolerances.
	Carburation.
C.1.	The Stromberg injection carburettor.
C.2.	S.U. Injector Pump.
C.4.	Hobson—R.A.E. Master Control Injector.
C.5/6.	Hobson Master Control Carburettors, Maintenance Instructions for all types.
C.7.	Hobson Master Control Injector—Repair and Re-conditioning Schedule.
C.8.	Hobson Master Control System for aircraft engines.
C.9.	Basic Principles of Hobson Aircraft Carburettors.
	Fuel Systems.
F.S.2.	Fuel/Oil Systems for Rolls Royce Derwent.
F.S.4.	Fuel Injection for Wright Engines.

(*cont.*)

MATERIALS.

CODE NO.	
M.1.	Essential Metallurgy for Engineers.
M.2.	Selecting Aircraft Timber.
M.3.	Mechanical Testing of Metallic Materials.

INSPECTION PRACTICE.

I.S.1.	Engineering Inspections.
I.S.2.	Magnetic Crack Detection.

Statutory Instrument, 1949, No. 374:—The Air Navigation (General) Regulations, 1949. (Pub. by: H.M.S.O.).

Statutory Instrument, 1949, No. 349:—The Air Navigation Order, 1949. (Pub. by: H.M.S.O.).

Statutory Instrument, 1949, No. 375:—The Air Navigation (Radio) Regulations, 1949 (Pub. by: H.M.S.O.).

British Civil Airworthiness Requirements. (Pub. by: A.R.B.).
Civil Aircraft Inspection Procedures. (Pub. by: A.R.B.).

Notices to Licensed Aircraft Engineers and Owners of Civil Aircraft. (Pub. by: A.R.B.).

A.R.B. Handbook No. 1. (Pub. by: A.R.B.).

A.R.B. Handbook No. 3. (Pub. by: A.R.B.).

A.R.B. Handbook No. 5. (Pub. by: A.R.B.).

A Specimen Maintenance Schedule (Pub. by: S.L.A.E.).

The foregoing is a selection of the books available to members of the Society from the Technical Library at Head Office. The Library also includes the maintenance and overhaul manuals for the majority of aircraft, engines and associated equipment in civil use in the United Kingdom.

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The COLLEGE of AERONAUTICAL & AUTOMOBILE ENGINEERING

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